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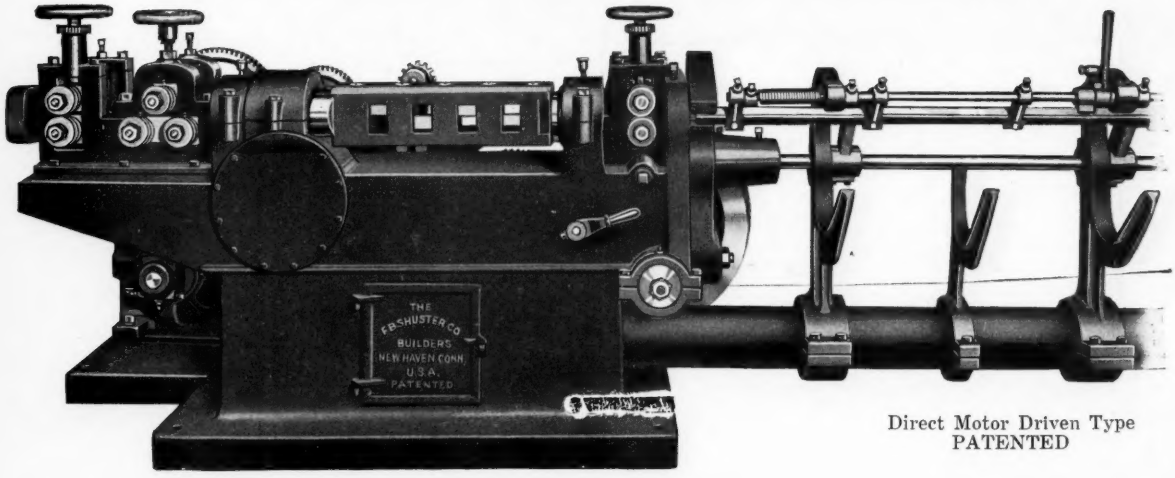

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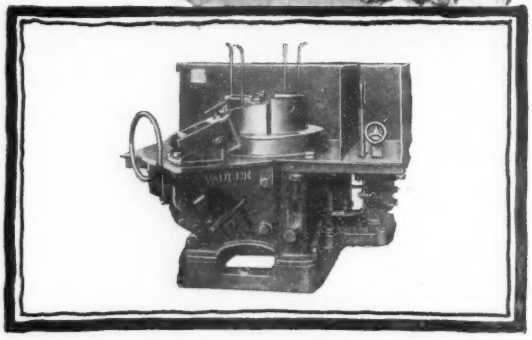

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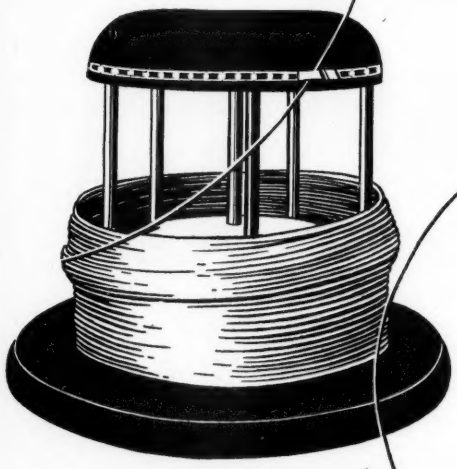

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WIRE & WIRE PRODUCTS

A monthly publication devoted to wire drawing and wire forming

Vol. 3 April, 1928 No. 4

Contents

Experiments Concerning Annealing Wire of Various Metals, By P. Siebe - 115
Translated from the Zeitschrift fur metallkunde by Paul H. Wueller.

British Cable Imports To Bear Mark of Origin - - - - - 118

Production of Tinsel By The Wire Manufacturer, By Harrison B. Williams 119
Possibilities of wire manufacturers in the tinsel field and design of equipment.

Cable Displays at British Industries Fair - - - - - 121

Load Variations in Helical Springs, By Robert C. Jordan - - - 122
The theory of load variation and graphs for redesigning helical springs.

Digest of Current Literature on Wire - - - - - - 125

How To Unreel, Splice Wire Cables - - - - - - 125

Preferred Characteristics of Rope for Oil Wells - - - - 125

Winding Ordinary and Special Coils Automatically - - - - 125

Wire Galvanizing Methods Discussed, By Clement F. Poppleton - - 128
Process of wire galvanizing and the equipment used is treated in a non-technical manner—Directions for dressing and dross sweating given.

News of the Industry - - - - - - - - 130

British Hooks and Pins Inquiry Concluded - - - - - 130

New Oil-Proof Electric Cable Introduced - - - - - - 130

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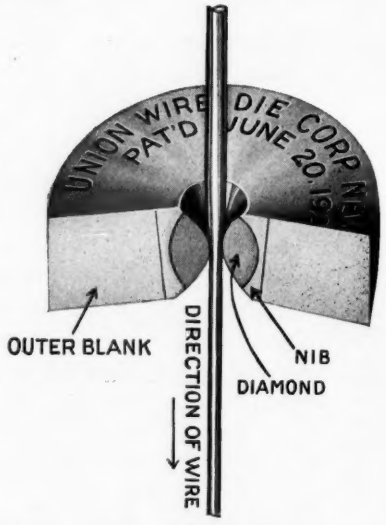

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WIRE
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Vol. 3 APRIL, 1928 No. 4

Experiments Concerning Annealing Wire of Various Metals

By P. Siebe

Translated from the Zeitschrift fur Metallkunde by Paul H. Wueller

THE soft-annealing of hard-rolled or drawn wire necessitates a longer duration of the annealing process than one should expect. This is primarily due to the relative quantity of the annealed material, and the slow transmission of the heat—a consequence of the air space in the oven. Laboratory experiments for the determining of the shortest annealing time for soft metals, too, show clearly the slow heat transmission which is charateristic of all annealing in the air, and which naturally results in a prolongation of the necessary annealing time. A correct conception of the actual conditions concerning duration and temperature of the annealing process can only be obtained, if one succeeds in reducing the time of heat-transmission to a minimum.—

In the following, we shall describe a few experiments with electrolytic copper, refined copper, bronze (B.2), brass Ms 67, aluminum, and iron wire. In the course of these experiments, we accelerated the heat-transmission up to a maximum. Hence, our results very well illustrate the relation between the duration of the annealing process and the temperature at which it is performed, and permit us to fix the shortest annealing time accurately.

Annealing of electrolytic copper wire, refined copper wire, bronze wire (B.2), brass wire, and iron wire in the salt bath. —Influence of temperature and time upon the tensile strength. —Determination of the shortest annealing time.—

When attempting to accelerate the heat-transmission one has two alternatives: annealing by means of electricity or annealing in the salt bath. Annealing by sending a strong current of low voltage through the wire cannot very well be used, if one is interested in accurate observation, because the fixation of a definite temperature, even with current of various voltages, is impossible. The temperature (in the case of electric annealing) increases with an increased duration of the currency flow, and the rate of the temperature increase can only be accelerated by application of higher voltages. Hence, we used salt baths exculsively. Heat is much more rapidly transmitted in the salt bath than in the air, because salt is a much better conductor and has a higher specific heat than metals. The last property is instrumental in preventing the formation of salt crystals when the cold wire is being dipped. We used Kroeber's Salt Bath which consists of even proportions of K No. 3 plus Na No 2.

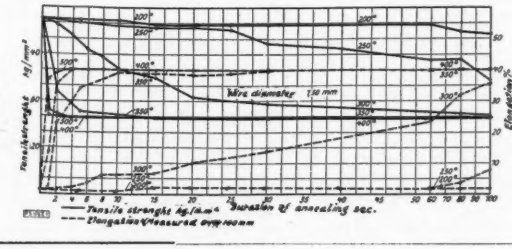


Fig. 1—Influence of annealing time on tensile strength of electrolytic copper wire.

TABLE 1

No.	Substance	Analysis %	Dia. of wire mm	Tensile strength kg/mm²	Elongation % per 100 mm
1	Electrilytic Copper	Cu 99.92 O 0.05	1.50	47.0	1 - 2
2	Refined copper	Cu 99.61 Ni 0.20 As 0.15 O 0.02	1.50	57.0	1 - 2
3	Bronze B2	Cu 99.40	1.50	73.0	1. - 2
4	Ms 67	Cu 66.06 Pb	1.50	57.0	2
5	Aluminum	Fe 0.40 Si 0.32	2.00	21.0	4
6	S. M. Iron	C 0.10	1.40	83.0	1 - 2

This bath can be used down to temperatures of 200° C. Corrosion of the tested wire—except in the case of iron-wire, annealed at very high temperatures—has not been observed. Slight discoloring however, occurred in most cases.

We used cold-drawn wire of 1.50 mm. dia. as test material. More detailed information concerning the properties of the material may be obtained by inspection of Table No. 1.

Our experiments were conducted as follows:

By means of an electric system, the salt bath was heated up to the required temperature. To assure uniformity of temperature, we stirred the solution. After the constancy of the temperature had been made certain—we kept it under control by means of a thermoelement—we introduced after five minutes the individual samples. The samples were loop-shaped. We placed them—in order to prevent contact with the bottom of the tube—upon a wire scaffold. Thus, they were kept in the centre of the bath. The annealing time was brief. It varied from 1 to 100 sec. Upon completion of the annealing process, the samples were taken out with tongs. These tongs, too, had remained in the solution. To prevent further self-annealing, due to the heat in the material, the samples were at once chilled in running water.

The temperatures applied varied also. They were chosen so as to permit accurate calculation of the "softening" process at any given temperature.

We repeated each experiment once, and tested the tensile strength and elongation of each sample. The sample pieces measured 100 mm. The results of these tests have been combined into an average. For each sample, the values are entered with respect to the various temperatures.—

Electrolytic Copper: (See Fig. 1)

The following temperatures were used: 200, 250, 300, 350, and 400° C. The values for wire, air-annealed at 500° C. were: tensile strength—26.0 Kg/mm²; expansion—41 per cent. If one traces the development of the "softening" as dependent upon the duration of the annealing process at various temperatures, one will find, that the wire, after 100 sec., at a temperature of 300° C., is thoroughly annealed with regard to tensile strength, while elongation, under the same conditions, does not yet reach a maximum. Beginning with 350° C. the influence of the temperature increases. The wire (at 350° C.) becomes "soft" after five sec., with respect to tensile strength, while it takes ten sec.—the conditions remaining constant—to soften it with regard to elongation. At a temperature of 500° C. the softening with regard to elongation being after 2 seconds.

Refined Copper (See Fig. 2)

The annealing experiments with refined copper wire were performed at higher temperatures, because this material does not soften so easily. These temperatures were: 300, 400, 500, and 600° C. The values after one hour of air-annealing were (at a temperature of 600° C.): 26. 5kg/mm² for tensile strength, and 32.5% for elongation. If one considers the individual values, as represented by the curve, from the point of view of softening, one will find, that no substantial decrease in tensile strength or increase in elongation was observed before the temperature reached 400° C. It takes 60 sec. to soften the wire, while it takes 100 sec. until the wire reaches its maximun elongation. The rate of softening is accelerated at 500° C. At a temperature of 600° C., it softens after two sec. with respect to tensile strength, while it softens after 8 sec. with regard to elongation.

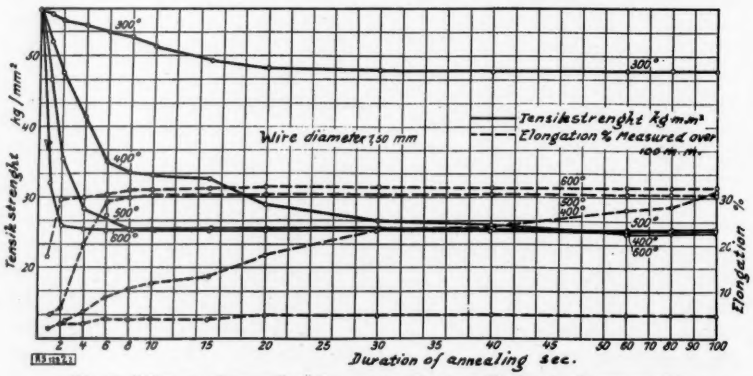


Fig. 2—Influence of annealing time on tensile strength of refined copper wire.

Conductive Bronze (B.2)

The wire samples of conductive bronze were annealed at 300, 400, 500, 550 and 600°C. The at 600°C. annealed wire showed a tensile strength of 29kg/mm², and an elongation of 32 per cent. At a temperature of 400°C, the influence of the annealing time upon the tensile

strength becomes marked. At a temperature of 500°C, the wire is thoroughly annealed (after 20 sec.) with respect to tensile strength, while it takes 30 sec. to effect the same with regard to elongation. At a temperature of 600°C. the softening point is reached in 2 sec. with

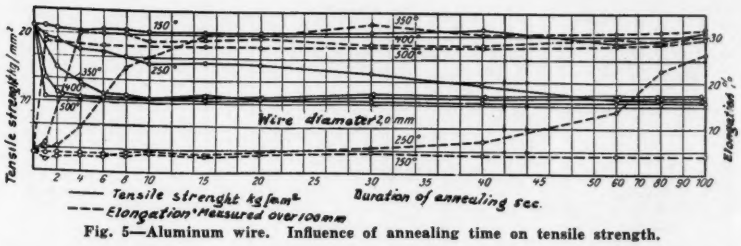
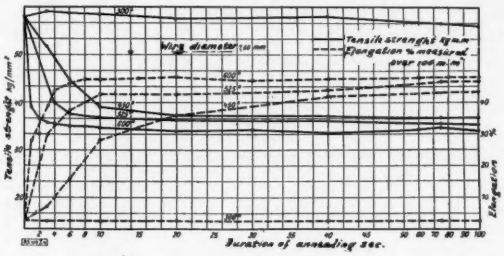


Fig. 5—Aluminum wire. Influence of annealing time on tensile strength.

Fig. 3—Bronze wire (B II) Influence of annealing time on tensile strength.



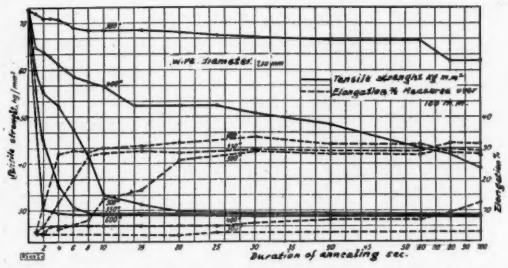


Fig. 4—Brass Wire (Ms 67) Influence of annealing time on tensile strength.

regard to tensile strength, and in 4 sec. with respect to elongation.

Brass Wire (Ms 67)

The experiments with this wire were performed at the following temperatures: 300, 450, 525, and 600°C. Wire of this type, when air-annealed had at 600°C. a tensile strength of 31kg/mm², and an elongation of 52 per cent. If one observes the trend of the curves, one will find that the softening process begins at 450°C. The tensile strength reaches after 40 sec. the approximate values for soft material, while it takes the elongation only 20 sec. to reach this point. With our annealing time, however, this value will not be reached. At a temperature of 600°C, the wire is soft after 3 sec. with respect to tensile strength, and after 8 sec. with regard to elongation.

Aluminum Wire

The following temperatures were used: 150, 250, 350, 400, and 500°C. The values for this wire were after 30 minutes (at a temperature of 400°C) as follows: tensile strength 10.5kg-/mm²; elongation 20 per cent. The curves show a marked effect of the time element only at a temperature of 250°C. The elongation, however, does not even reach the maximum point after an exposure of 100 seconds. At a temperature of 350°C., the softening with regard to tensile strength becomes effective after ten sec., while the elongation reached its maximum value after 15 seconds. At temperatures of 400°C. and 500°C., one observes that the critical points with respect to tensile strength are somewhat higher than at 350°C. (the time remaining constant). The elongation point, however, lies relatively lower. These results agree with those of O. Bauer, whose investigations show, that annealing temperatures (for aluminum) higher than 400°C. result in an increase in tensile strength, and in a decrease in elongation. Bauer explains this as "an aging phenomenon of metal." As to thorough annealing, higher temperatures are of course more effective, but if we have to consider the quality of the material, we should use medium temperatures (350°C.).

S. M. Iron Wire

The following temperatures were used in connection with iron wire: 600, 700, and 800°C. The values for tensile strength and elongation after annealing (duration of the process: One-and-a-half hour) and chilling were: 44.5kg/mm² for tensile strength, and 23% for expansion. This experiment, however, does not give a clear picture concerning the softening, because we passed the Perlit-Point A1. Nevertheless, it is interesting to compare our results with data obtained from other experiments. No marked effect upon the tensile strength was noticed at 600°C. At 700°C., however, the softening with regard to tensile strength took place in ten sec., while it took 20 sec. with respect to expansion. At 800°C. extraordinary phenomena entered. As a consequence of passing the Perlit-Point A_1 the chilling caused an additional annealing which became especially marked after 30 seconds. The experiment furthermore shows that one needs in the case of iron wire

TABLE 2
SUMMARY OF ANNEALING TIMES AT VARIOUS TEMPERATURES

	Annealing time in sec. at temperatures ° C.										
Material:	200	250	300	350	400	450	500	550	600	700	800
Electr. Copper	...	...	100	5 (10)	2 (4)	.....	1 (2)	.....	.....	.....	.....
Refined Copper	...	...	...	.....	60 (100)	.....	8 (10)	.....	2 (8)	.....	.....
Cond. Bronze (B.2)	...	...	...	.....	.....	.....	20 (30)	8 (10)	2 (4)	.....	.....
Ms 67,	...	...	...	.....	.....	20 (40)	8 (30)	3 (8)	3 (8)	.....	.....
Aluminum	...	...	...	10 (15)	2 (4)	.....	1 (1)	.....	.....	.....	.....
S. M. Iron	...	...	...	.....	.....	.....	.....	.....	.....	10 (20)	10 (10)

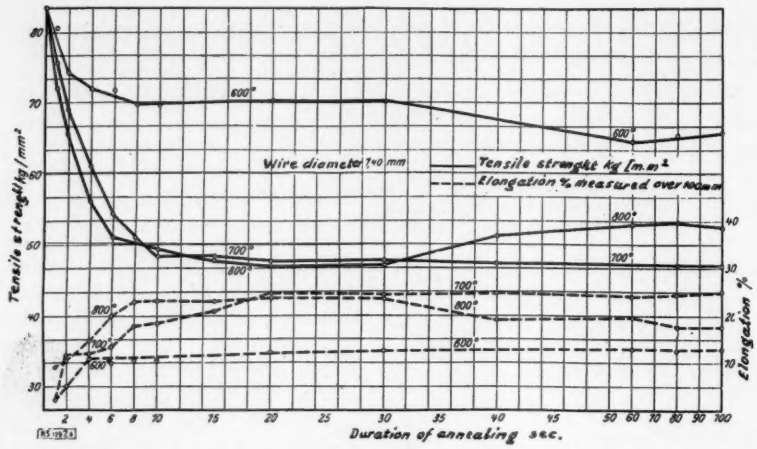


Fig. 6—S. M. Iron wire. Influence of annealing time on tensile strength.

relatively short annealing periods in order to reach—at the fixed temperatures and with all other conditions remaining constant—the softening point with respect to tensile strength and expansion.

Summary

Table 2 gives a graphic presentation of our annealing experiments. It represents the shortest annealing time for the various temperatures. It is characteristic that in the majority of cases the expansion reaches its maximum after comparatively longer time than is needed to soften the wire with respect to tensile strength. If one compares the time periods necessary to soften the material, one will find that they are under our condition exceptionally brief. They run up to two sec. for the most often used, low annealing temperatures. The following order with respect to low annealing temperature and brief annealing time may be established: electrolytic copper, refined copper, conductive bronze, and brass M₅ 67. The relatively high annealing temperature of aluminum as contrasted with copper, too, should be noted.

British Cable Imports To Bear Mark of Origin

THE report of the Standing Committee appointed by the British Board of Trade under the Merchandise Marks Act, 1926, with regard to insulated electric cables and wires has just been issued by the Govment Stationery Office in London.

In the report the Committee states that the applicants were the Cable Makers' Association, who were supported at the inquiry by the Independent Cable Makers' Association and the Metropolitan Electrical Cable and Construction Company, Ltd. The application was in regard to imported electric cables and electric wires of all descriptions, but willingness was expressed to exclude cables and wires imported as part of some complete article, provided they were integral parts of the article or were necessary accessories thereto, and did not exceed the amount commonly sold with the article. The applicants requested that the goods should be required to bear an indication of origin not only at the time of sale, but also at the time of importation. Seven witnesses on behalf of the applicants and six on behalf of the opponents were heard by the Committee.

On a careful review of the evidence, arguments and exhibits the Committee finds that, as regards some of the categories, there is an appreciable possibility of purchasers being unaware, in the absence of marking, of the origin of the goods they purchase. This conclusion is confirmed by the wording of some of the catalogs and advertisements produced, which in the Committee's opinion are calculated to suggest that imported goods are British. It is equally apparent that in the case of large underground cables the possibility of the purchaser being misled is relatively remote, unless the claim of the applicants be admitted that, in the case of a municipal electrical supply undertaking, the individual ratepayer should be deemed to be the ultimate purchaser. Technically the corporation is the purchaser, but the required information could be given to the ratepayer by the conspicuous marking of the drums on which underground cables are wound.

Having regard to the possibility of misapprehension as to the origin of some of the categories of imported goods, the difficulty of drawing a clear distinction between those categories and others in which the possibility is less, and the evidence of misleading descriptions in catalogs and advertisements, the Committee has arrived at the conclusion that, subject to the exclusion of cables and wires imported as part of some complete article, it is desirable that an indication of origin should be required. The marking requirement should, however, be as simple as possible and should impose the minimum of trouble and expense on those who have to comply with it. The Committee is unable to accept the contention of the opponents that the price is always a sufficient indication of the origin of the goods, or that all the drums, coils, reels, spools, or bobbins on which the goods are imported already bear a sufficient indication of origin.

The Committee sees no ground for requiring any external mark in the case of underground cables, considering that all that is necessary is an indelible mark of origin on the

(*Please turn to page 139*)

Production of Tinsel By The Wire Manufacturer

Possibilities of wire manufacturers in the tinsel field and design of equipment

By Harrison B. Williams

WHILE tinsel thread is by weight from 70 to 90 percent metal except in the larger and coarser sizes and while it all has wire as its origin yet the field as a manufacturing field is so highly specialized and involves so many intricate operations that it lies nearer to the field of the textile manufacturer than it does to the wire manufacturer's province.

However the field of the tinsel manufacturer is so large and the money value of the importations so great that there are many parts of this interesting and profitable field that come within the reach of the progressive wire manufacturer.

Tinsel manufacture includes such widely differing products as pot rags selling at ten cents each and brocade selling at fifty dollars a yard. Tinsel is found in telephone cords. On Christmas trees, inside radio sets, on mi-lady's hat; on her shoes; her gowns may be made of it; the officier's uniform is identified as to rank by it. Shrouds for sacred elephants in India are made of it and sometimes cost one hundred thousand dollars each.

In the manufacture of tinsel there are many arts involved. The metallurgist, the electrochemist, the wire manufacturer the rolling mill designer, the textile machinery designer, the special machine builder, all have made their contributions which have been coming in for several thousand years since the ancient Egyptians made the first tinsel we know about.

The wire manufacturer investigating the tinsel field for the purpose of finding a point where he may enter, at once discards the thought of weaving brocades of silver or gold cloth. Looms are a mystery to him and he intends that they shall so remain. Telephone cords may look to him somewhat less difficult to make. He is accustomed to the braiding machine. Insulated wire has made it a familiar object to him and the tinsel conductors inside the telephone or radio cord appear to him as a possibility within his reach. Investigation shows that between the fine wire used as the starting point in this and the finished cord there are three operations two of which require equipment not purchaseable on any terms. He must have tinsel rolling mills and he must have serving frames to wrap the rolled tinsel around the thread center of the conductor. He must also have a twister but this thanks to the Bronnell Co., he can buy.

In order to secure tinsel rolling mills he must first design and then have built machines that will roll a wire three and one third thousandth of an inch in diameter to four diameters wide. Not only must the mill roll this ribbon but it must be fitted

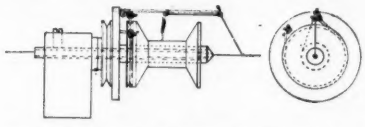


Fig. 1—French wood serving head which may be used as basis for design of tinsel serving head.

with a spooling device that will spool it and this he soon finds cannot be done by any existing wire spooling mechanism.

As to the serving, he finds that in order to get tinsel serving machinery he must design and build it.

Having progressed thus far in his investigation he decides to look for other tinsel fields within his range without becoming involved in the loom weaving part of the industry. He finds that every Christmas there is a huge consumption of tinsel garlands which requires upwards of a million pounds of silver plated tinsel ribbon annually, now imported from France and Germany to be woven here on Wiebske machines into garlands. He finds that in order to match the plating quality of the European silver plated wire he must build single block machines and draw the wire after plating one pass at a time in order that the scouring action of the multiple die machine may be eliminated.

Having completed his rolling mill research and with successfully operating rolling mills and with his plating equipment functioning satisfactorily and with special miniature single pass blocks for dry wire drawing and with standard garland machines he has a tinsel industry that cannot be attacked by European price cutting. The spread between the selling price of garlands and the imported cost of silver plated tinsel ribbon is too great to permit his being undersold by any cuts on the price of imported ribbon.

With tinsel garlands as his sole product in the tinsel field he decides to add another line or two and finds that the same marketing organization that is selling his garlands can market space cord and pot rags.

For the production of pot rags he has a wide variety to choose from. Tinsel scouring rags and devices being very common in Europe where hot water is not as common as here.

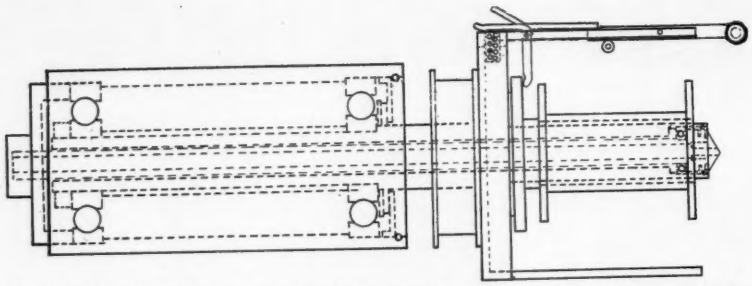


Fig. 3—Ball bearing tinsel serving spindle with automatic tension and with flier unaffected by centrifugal force.

He finds that he can make pot rags by knitting tinsel ribbon on a standard knitting machine using the same method of delivery of ribbon to the machine that he is using for his wire delivery into his rolling mills. This knitted tinsel coming from the machine in the form of a hollow tube is wadded into a ball and the end pulled over the ball much as a sock is made into a ball package by the housewife. Or he may serve the tinsel loosely around a pin and either knit or weave the tinsel covered yard into tinsel rags. He may even rig up a warp of these tinsel yarn ends and use a gang sewing-machine to sew parallel lines of chain stitching across the warp making one rag at each crossing.

Space cord requiring serving frames he may decide to experiment in this direction and there being no source of serving spindles he buys a short spooling frame from the textile manufacturer and starts to experiment with serving heads of his own design. With a French wood serving head as shown in the cut No. 1 as the basis of his development he attempts to reproduce this in such form that it may be manufactured by American Automatic machinery and at the same time he aims at a design that will permit high speed and be easier to operate than the French type which requires a great amount of skill to operate in production on a large scale.

His experimental serving heads he mounts in the spooling frame in a top rail which he adds for the purpose and drives them by means of round belts or flat bands from a drum running the length of the frame. This drum is located underneath the frame and mounted upon ball bearings for the high speed required.

In order to pull the thread he wants to serve with tinsel ribbon through the serving head he fits the frame with an outboard shaft carrying a pulling wheel or tapered wheel opposite each serving head and from these pulling wheels the served thread goes to the take up spool as it did when the frame was used as a winder.

If he is to serve space cord with twenty five turns of tinsel ribbon per inch he will need one ratio between the drum speed and the pulling wheel but if he wants to change to telephone tinsel at seventy five turns of tinsel ribbon per inch he will need a spindle to pulling roll ratio three times as high. In order to effect a quick change over when required he fits the frame end with a removable intermediate gear and supplies himself with a series of gears to give any lead he may require.

Finally he hits upon a serving head design similar to the one shown in the drawing No. 3 and he is now in the serving field not only for the easily served space cord but for all tinsel thread purposes.

His next step is a harder one. He finds that he cannot roll wire of a diameter less than .0029″ to the width of four diameters that the imported tinsel ribbon measurements indicate their .002″ diameter wire is being rolled to, and as the very high price paid for small tinsel embroidery thread tempts him to try to make this he looks around for the reason why his mills will not roll such wire to the required width.

He finds that in France the mills used for small wire are not flat roll mills but have crowned rolls and have a radius on the crown of about four inches. It occurs to him that the reason for this is that the spring of the steel roll under the enormous pressure at the point where the wire passes between the two rolls is such that it causes the steel roll to spring or bend away from the wire and form an elliptical opening between the two rolls and that if a round face roll set is used the roll bending would result in a flat surface roll at the point of contact of the two rolls. He tries this and finds that he can now roll .002″ wire to the four diameters he requires. He attempts to serve this upon his ball bearing spindle and finds that the spindle is much too large. That the smallest spool he can put upon it is far too heavy to operate with a tinsel ribbon only four tenths of a thousandth of an inch thick. He redesigns the serving head and comes back to the French practice of a fitted spindle and as this gives only about 4000 revolutions per minute he designs a small ball bearing spindle as shown in drawing No. 4.

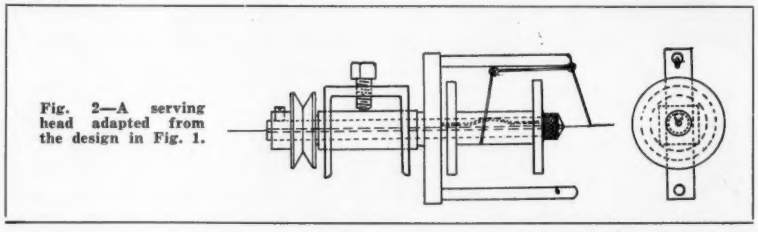


Fig. 2—A serving head adapted from the design in Fig. 1.

The rich field of the brocaded silver and gold fabrics he does not try to enter nor is he very successful in efforts to cooperate with textile mills desiring to make these fabrics from tinsel yarns bought from him as the

problems arising in the weaving are beyond the experience of the textile man not acquainted with the behavior of tinsel in its many different forms. The textile mill desiring to make a specific pattern must use tinsel yarns adapted to that use the only completely satisfactory solution of this problem being the manufacture of the entire product under one roof.

To the wire manufacturer entering the field there are many and large fields open such as Telephone Cords, Tinsel Garlands, Space Cord, Embroidery Thread, Pot Rags, and in these fields he has every advantage over the textile manufacturer desiring to enter the field but in the silver and gold cloth field and in the specialty tinsel fabric field the textile manufacturer with a tinsel rolling and tinsel serving plant under his roof is the only solution to the transfer of this huge industry to the United States.

The plating of tinsel wire having already been explained in the columns of this journal the remaining steps in the tinsel industry as available to the wire manufacturer together with the apparatus required will be explained in the order here listed.

2. Tinsel Rolling Mills. (Roll Stand. Creel. Spooling Device. Accessories.)
1. Tinsel Serving Heads.
1A. Tinsel Serving Frames.
3. The Tinsel Garland Machine.
4. Space Cord Balling Machine.
5. Knitting Pot Rag Tinsel.
6. Telephone Cord Machinery.

An article on the Progress of the Electric Cable Industry in Great Britain will appear in the next issue of WIRE & WIRE PRODUCTS

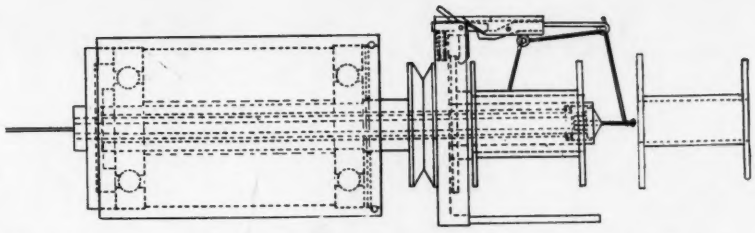


Fig. 4—Serving head with fitted spindle designed according to French practice. The spindle is provided with ball bearings.

Cable Displays at British Industries Fair

THE Birmingham Section of the British Industries Fair, Europe's greatest annual trade fair, this year formed the largest and most comprehensive exhibition of the work of Britain's heavy industries that has ever been brought together.

Among the exhibits of outstanding importance were those of the cable manufacturing undertakings. The Cable Makers' Association had a stand on which there was a joint exhibit prepared by some of its members to show the various types of cable used in electric light and power installation. These included rubber insulated cables with various protective coverings both metallic and non-metallic in single core, concentric and multicore types. Special systems of wiring for houses, telephone cables for under ground work, heavier cables for street mains, factories and power transmission, and super-tension cables for distribution at the highest pressures were all included on the stand. Eighteen manufacturing firms contributed to this combined exhibit.

Callender's Cable & Construction Company had a stand on which it featured cables rubber insulated and paper insulated for voltages ranging from 50 to 132,000 volts. Demonstrations were given daily with the Callender-Wilson automatic plumber, a device which enables cables to be joined in fiery mines, or in similar explosive positions by an electrical process. It can also be used with blow lamps for ordinary work.

The Macintosh Cable Company had as the principal feature of its exhibit two developments in the application of its "Maconite" insulated cables. The first is the Macintash industrial wiring system, of which a complete range of accessories was shown. This system has recently been introduced to extend to all parts of a circuit the protection given hitherto by "Maconite" to the conductors of the cables. The accessories shown were made in a moulded insulating material which is unaffected by fumes or moisture. The cables are led into the fittings through glands of "Maconite," with which the accessories are rendered gas-tight. A special tool is provided for piercing the glands where necessary to take the cables. The system is designed for the wiring of factories and other buildings where destructive fumes and moisture are present.

The second special application of "Maconite" featured was not entirely new, but it is a development of the Macintosh overhead distribution system to reduce the cost of electricity supply to housing schemes, villages, etc., where buried mains would be prohibitive in price. Supply is led from house to house by means of special "Maconite" insulated cables, supported in porcelain cleats beneath the

(*Please turn to page 140*)

Load Variations in Helical Springs

The theory of load variation and graphs for redesigning helical springs

By Robert C. Jordan

THE machine designer usually calculates or develops by trial, a helical spring with a combination of dimensions which allow the spring to exert the required pressure or pressures when placed in operation. A quantity of springs may be ordered to the dimensions of the trial spring. If the machine on which the springs are used is particularly sensitive to slight variations in the load applied, it will probably be found that some springs operate satisfactorily, some are too strong or exert too great pressure and that others are too weak. Unless the springs are examined carefully, no difference may be noted in those which prove correct and those which do not operate.

Frequently, the spring designer also wishes to know how much a small variation in wire size will vary the load test of a helical spring. Again, in the shop, the operator has a spring which is a little too weak and wonders just what the diameter should be to give exactly the load required. These conditions, of course, occur in helical springs designed to operate in tension, compression or torsion but while part of the following discussion may apply to all three types, the formula and graphs have been outlined for compression springs only.

In the following paragraphs, an effort has been made to show the derivation of an error calculation from a formula and to explain its application to the design and redesign of springs.

A common form of the round wire helical spring formula is,

$$f = \frac{8\,P\,D^3}{G\,d^4}$$

Transposing and substituting F/N for f,

$$P = \frac{F\,G\,d^4}{8\,D^3\,N}$$

Where

D=Mean diameter of Coil (Inches).
G=Modulus of Rigidity in torsion (Pounds per Sq. Inch).
F=Total Deflection (Inches).
N=Number of Active Coils.
P=Axial Load (Pounds).
d=Wire Size (Inches).
f=Deflection per Coil (Inches).

If it were necessary to determine the variation in load due to a ±.001″ variation in wire size, the designer would ordinarily substitute the two values of d in the formula and solve for the two values of P. Following is outlined the derivation of a simplified formula, making it possible to calculate quickly the variation in P due to a variation in wire size or of any other term in the original spring formula.

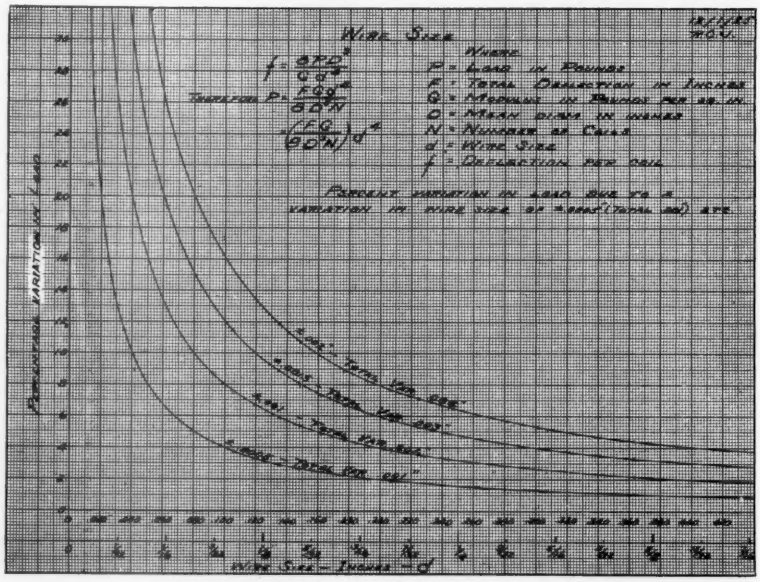
Taking the logarithm of the above equation,

Log P=log F + log G + 4 log d—log 8— 3 log D—log N.

By differentiating,

$$\frac{dP}{P} = \frac{dF}{F} + \frac{dG}{G} + \frac{4\,dd}{d} - 0 - \frac{3\,dD}{D} - \frac{dN}{N}$$

There are both positive and negative signs in this formula. According to the theory of errors, the percentage of error in any product is equal to the algebraic sum of the respective percentage of errors of the several terms. Since these errors may be either positive or negative the maximum possible percentage of error will be the arithmetical sum of the several percentages. An assumption made at this point is that the errors are small, for the formula


Wire Size
Where
P = Load in Pounds
F = Total Deflection in Inches
G = Modulus of Rigidity
D = Mean Diam. in Inches
N = Number of Coils
d = Wire Size
f = Deflection per Coil
Percent variation in load due to a variation in wire size of ±.001 (one mil) etc.
Percentage Variation in Load
Wire Size — Inches

Percent variation in load as function of variation in wire size.

is not accurate for large errors. Practically, the calculated percentages and the figures obtained from the accompanying graphs are accurate to three figures up to values of about 20%.

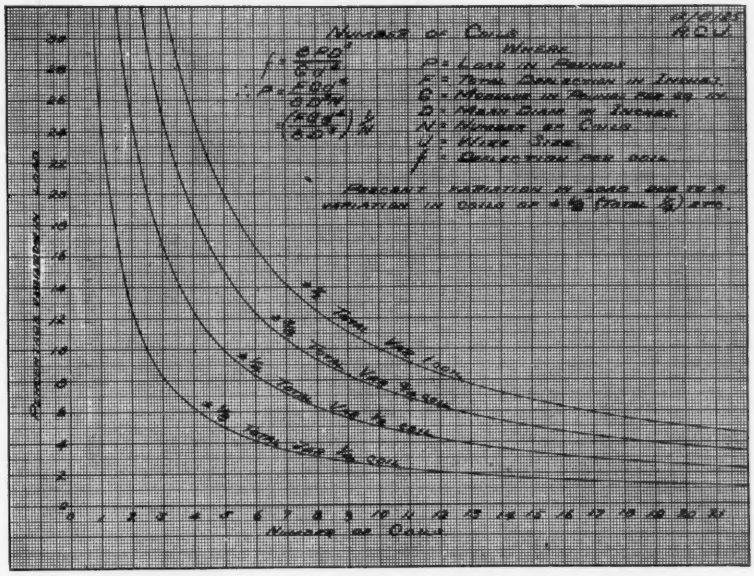
The term G is not constant. Tests have shown that G varies with the material, temperature changes, analysis of steel, heat treatment and, according to some authorities, with the stress and operation of the spring. The value used is largely up to the designer and may be in error by 10%. But, if we are considering the variation in load test of springs in a large lot, the variation in G will be small, because in any two of these springs, the material is practically the same and they are tested and operated under like conditions and temperatures. In the practical application of this formula, therefore, the term G has been considered constant, and since the derivative of a constant is zero, the formula is further reduced.

If the word variation is substituted for the word error, the formula for computing the variation in load between two similar springs, the first having all allowable variations tending to make it too strong, and the second having variations tending to make it weak, may be written.

$$\frac{\text{Variation in P}}{P} = \frac{\text{Var. F}}{F} + \frac{\text{Var dx4}}{d} + \frac{\text{Var Dx3}}{D} + \frac{\text{Var. N}}{N}$$

$$\frac{\text{Variation in P}}{P} \times 100 = \text{Percentage Variation.}$$

This formula may be applied only when the conditions imposed allow the spring to recover its original length after deflection. Thus, it may be applied to a spring in which the stress is too low to cause set or permanent deformation at the required load or to a spring from which all set has been removed. No mention has been made of the effect of plain ends or of squaring and grinding because the difference in length of wire required due to type of ends is taken care of by the allowance for inactive coils.



Percent variation in load as function of variation in number of coils.

Let us now find the effect of a small variation in the wire size upon the load test. Assume all terms in the formula to remain constant except the wire size. The variation in P equals four times the variation in d divided by d for, if the other terms are constant, their variation is zero. We may also find the variation in load due to changes in any or all of the other terms in the formula. For example. Find the possible load variation between two springs from a large lot in which the following variations were allowed.

Dimension		Limits	Total Variation
Length	7″	±1/16	1/8
Wire Size	No. 7 (.177)″	±.0015	.003
Mean Diam	1 7/16″	±1/16—1/32	3/32
Number of Coils	14	±1/4	1/2
Spring to hold 90 lbs. at 4½″			
Deflection	2½″	±1/16	1/8

$$\frac{\text{Variation in P}}{P} = \frac{\text{Var. F}}{F} + \frac{\text{Var d x 4}}{d} + \frac{\text{Var D x 3}}{D} + \frac{\text{Var. N}}{N}$$

$$= \frac{\frac{1}{8}}{2\frac{1}{2}} + \frac{.003x4}{.177} + \frac{3/32x3}{1\ 7/16} + \frac{\frac{1}{2}}{14}$$

$$= .050 + .067 + .195 + .036 = .348$$

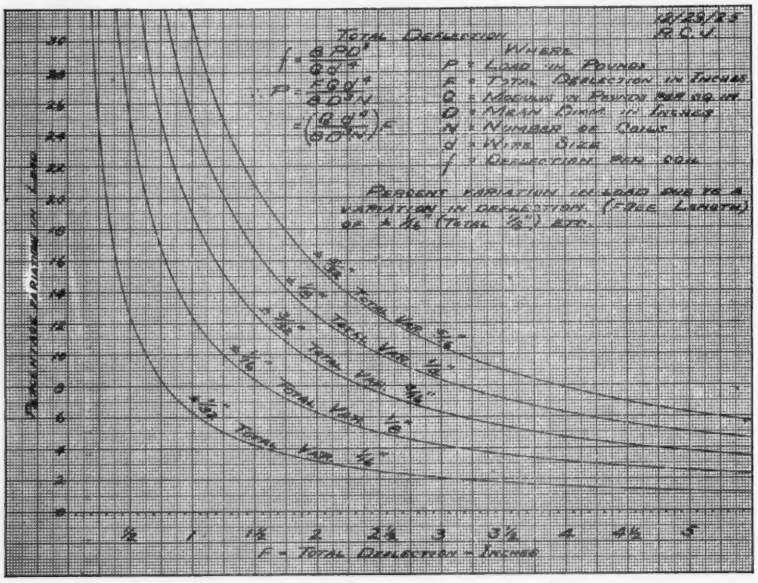
$$\text{Percent Var.} = .348 \times 100 = 34.8\% = \pm 17.4\%$$

In this example it should be noted that over half of the possible variation in the spring was due to the allowance in Mean Diameter. In actual manufacture some of these allowances will be reduced; moreover, one variation in a spring will frequently counteract another in its effect upon the load test.

Explanation of Graphs

On each of the four graphs, the term for which the graph is made may vary, while the values of all other quantities in the formula remain constant. The graphs may be used for two purposes, either to obtain individual percentages as in the example above, or to redesign a strong or weak spring.

To use the graph for the first case, trace vertically from the


Total Deflection
Where
P = Load in Pounds
F = Total Deflection in Inches
G = Modulus of Torsion
D = Mean Diam. in Inches
N = Number of Coils
d = Wire Size
f = Deflection per coil
Percent variation in load due to a variation in deflection (Free Length) of ± 1/16 (Total 1/8") etc.
Percent Variation in Load
f = Total Deflection - Inches

Percent variation in load as function of total deflection.

wire size in question to the correct variation curve and from this intersection, trace horizontally to the required percent. For example, two springs in which the wire size varies from .079 to .081", that is, ±.001 or a total variation of .002", will vary in load test by 10% due to this cause alone. This means that if the test using No. 14 (.080) wire was 100 lbs., the .079" spring would hold 95 lbs. and the .081" spring would hold 105 lbs. This 10% could of course be written as + 5%. The values obtained by calculation in the first formula may be checked by using the four graphs.

In the second case, to redesign a strong or weak spring, trace horizontally from a calculated percent and vertically from the wire size. At the intersection of these lines read the variation or the amount by which the original value should be changed to give a load test weaker or stronger, as the case may be, by the percentage used. Interpolation of intermediate terms on any of the graphs is readily accomplished because the curves are separated both horizontally and vertically by equal spaces corresponding to equal changes in the variation. For example, a spring made of No. 11 (.1205) wire is found to hold 100 lbs. while the load should be 90 lbs. This spring is, therefore, 100-90/100 or 10% too strong. The wire size graph shows that if No. 11 wire is varied by .003 or, in this case, reduced to .1175" the load test will be reduced by 10%. It is usually better practice, however, to leave the wire size a standard dimension, such as No. 11, No. 12 or 1/8, and to obtain small variations by a change in diameter, number of coils or deflection. A 10% reduction in load test might be obtained either by increasing a 31/64" mean diameter to 1/2" or by an increase from 10 to 11 coils.

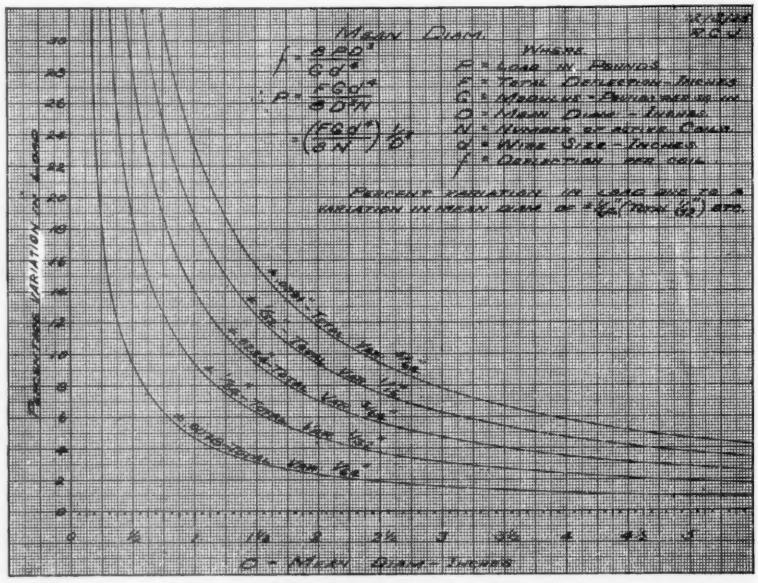
It should be noted that a change in number of coils with the same wire must result in an increase in free length if the pitch is maintained and in a change in solid height. A combination of the graphs may be used to cover almost any case.

The following table is evident from the formula but is placed here for ready reference.

To make a helical compression spring

WEAKER	STRONGER
Decrease Length (Deflection)	Increase Length (Deflection)
Decrease Wire Size	Increase Wire Size
Increase Mean Diameter	Decrease Mean Diameter
Increase Number of Active Coils (Length Constant)	Decrease Number of Active Coils (Length Constant).

In the case of extension springs the initial tension, that is, the load required to just open the coils should be subtracted from the load used in the formula. With an assumed constant initial tension the other variables may then be applied in the manner outlined.


Mean Diam.
Where
P = Load in Pounds
F = Total Deflection - Inches
G = Modulus of Torsion
D = Mean Diam. - Inches
N = Number of Active Coils
d = Wire Size - Inches
f = Deflection per coil
Percent variation in load due to a variation in mean diam. of ± 1/64 (Total 1/32) etc.
Percent Variation in Load
D = Mean Diam. - Inches

Percent variation in load as function of mean diameter of spring.

DIGEST OF CURRENT LITERATURE ON WIRE

How To Unreel, Splice Wire Cables

Care and Maintenance of Wire Rope, by W. Voigtlander, M. E., rope engineer, Amer. Cable Co., in Blast Furnace & Steel Plant, Nov. 1927, pp. 461-464.

Emphasis is laid upon the proper method of unreeling so that no kinks are formed. Once a kink is formed, no amount of twisting or straining will take it out, and the rope in substance becomes unsafe for use. Never uncoil wire in the same way that rope is uncoiled, is one of the pointers but lift the coil (of wire) onto its edge and unroll away from the end, allowing the cable to lay flat on the floor or earth. If a jack bracket is not available, turn the reel on edge and roll it away from the end, as with the coil.

Much space is given to a description of proper methods of splicing, the procedure, items of care, etc. In this the following useful table for splicing lengths is given. Make the length incorporated in the splice half of this being in each part, proportionate to the diameter of the cable as follows:

Diameter in In.	Length of Splice, Ft.
½	15
⅝	20
¾	24
Diameter in In.	Length of Splice, Ft.
⅞	28
1	32
1⅛	36
Diameter in In.	Length of Splice, Ft.
1¼	40
1½	45

This works out in rule form to a length (in feet) equal to 32 times the diameter (in inches), except for the smallest and largest, in which cases it is 30 times.

Preferred Characteristics of Rope for Oil Wells

The Wire Rope, by Percy R. Clark, in Inst. Petroleum Technology Journal (Roumanian Branch), June 1927, pp. 462-7.

This article reflects the uses of wire rope in the Roumanian oil fields, as in drilling, mining, etc. The normal wire rope used has six or more strands around a fiber core, each strand being of 7, 12, 19, 24, 27, 30, 37, 48, 61 or 91 wires. The 24s and 30s have an additional fiber core. In compound forms, wires of different gages are used. In the petroleum industry the ordinary or cross-lay wire is used, with the wires in one direction and the strands in the other. In mining the wire used has both the wires and strands laid in the same direction. There are two causes of rope destruction, (a) abrasion and (b) flexation. In the cross-laid rope, only the peak of the circumference of the strands is subjected to wear so the wear all comes in one place. In similar-lay rope greater resistance to bending is offered because the wires are not parallel with the rope or with each other but at varying angles. The ordinary lay is better fitted to resist the two main sources of destruction but tends to untwist so it can be used only when the ends are both fixed. Cable-laid rope consists of a number of ropes twisted around another fiber core. Hrabak gives this a high strain value. If a single wire is 0.6, that with two twists is 0.6^2 pr 0.36, 3-stage of cable laid 0.6^3 or 0.216. Woernle differs. He says if straight lay is 100, the average life of ordinary lay rope is but 26 and of cable-laid 14.

Concentric strand rope has not met with success because of the necessary pressure on the outer strands.

Flattened strand wire rope has a shaped center, also flat surfaces on the outside of each strand, giving a large surface to withstand wear, but is not so good in flexion.

Non-flexible or spiral rope has no core. In 7, 19 pr more wires per strand this is used for railway signalling, mine cages, and in large numbers of bridges. 37s to 61s are used for ropeways but usually the lock coil type is considered better. The outer layers of shaped wires or alternately shaped and round makes a useful rope, the flat surfaces giving a maximum resistance to abrasion. This is used for winding but is best for standing or taut ropes of cableways.

The Author goes into measuring, uncoiling, unreeling, seizing, causes of destruction (external, internal wear, vibration, corrosion), applications of wire rope to petroleum industries of Roumania, drilling ropes, etc.

In the discussion the Chairman disagreed as to wear by abrasion, ropes often failed but showed no abrasion whatever. Fatigue by bending is paramount cause, abrasion, corrosion, vibration secondary causes.

Winding Ordinary and Special Coils Automatically

Automatic Coil-winding Machines, by D. L. Roberts, in Machinery, Aug. 1927, pp. 890-892. Ills. of light and heavy coil winders.

The Author illustrates and describes in considerable detail some ingenious new machines for winding coils of all kinds, shapes and sizes, from all kinds, sizes and materials of wire. These machines work automatically and stop automatically for taps, at the end of a coil, if the wire breaks, when the wire supply spool is empty, etc. For smaller wire and smaller coils one machine can be adapted to radio transformer windings, tapped coils, charger windings, and to practically all other coils.

Sleeper & Hartley
TRADE MARK

Practical Continuous Wire

These Machines Go Into Production at ...—Re...

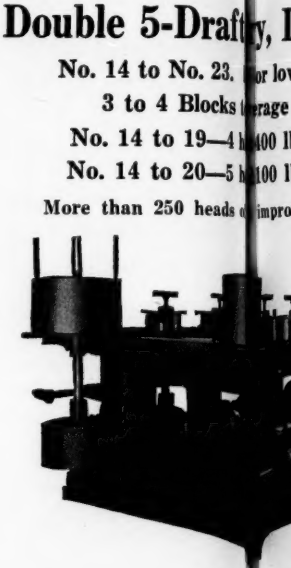
Rod Frame

(No. 5—14 or 15 wire)
Patented June 3, 1924—May 12, 1925—others pending

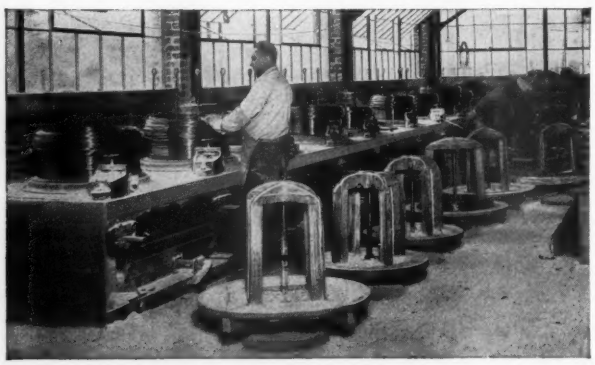
All Ball or Roller Bearings
No Differential Gearing.
Automatic Compensation for Speeds of Heads.

Double 5-Draft..., I...

No. 14 to No. 23. ...or lo...
3 to 4 Blocks ...erage ...
No. 14 to 19—4 h... 400 l...
No. 14 to 20—5 h... 100 l...
More than 250 heads ... impro...

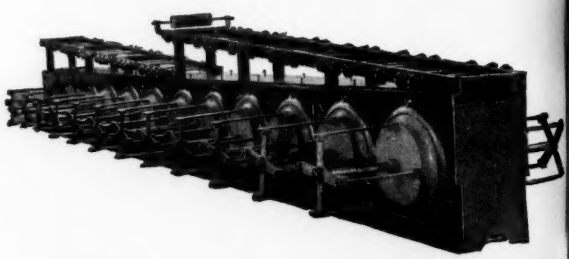


IMPROVED WIRE MILL EQUI...



Standard Rod Frame—10 Block

Long, Stiff Spindles, in anti-friction bearings, and equipped with friction Clutches. Powerful and reliable.
Practically noiseless in operation.
(New Plant of Thompson Wire Co., Worcester, Mass.)



Patenting Furnace Take-Up

(New Plant of Thompson Wire Co., Worcester, Mass.)

AGENTS: CHICAGO TERRITORY,
Neff, Kohlbusch & Bissell, Inc.

SLEEPER & ...

FOREIGN AGENTS AND REPRESENTATIVES: UNITED KINGDOM—Mr. Fredk. A. Perry, 63 Queen Victoria St., London, E. C. 4. FRANCE—Mr. Edgar Bloxham, 12 Rue du Delta, Paris. BELGIUM—Isbecque, Todd & Cie., 25-27 Boul. Emile Bockstael, Brussels.

WORCESTER, MA...

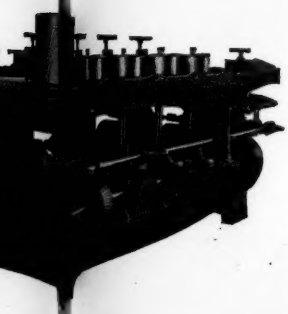
We Drawing Machinery

Sleeper & Hartley TRADE MARK

on at —Reducing Overhead-Increasing Production!!

Draftry, Intermediate

o. 23, or low carbon wire.
Blocks rage Operator.
19—4 400 lbs. per block.
20—5 100 lbs. per block.
heads improved model in operation

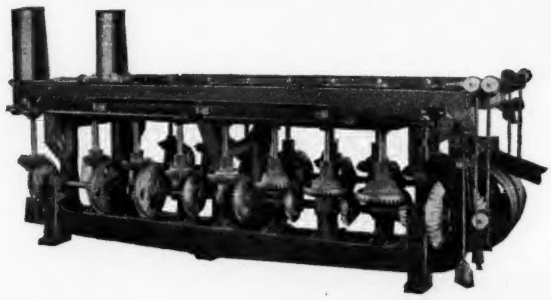


Double 8-Draft Fine Wire: Wet

No. 22 to 36. High or low carbon wire.

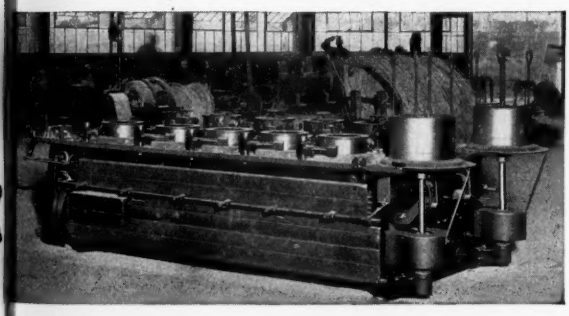
6 Blocks to Average Operator, 22-33, 8-hole, 660 lbs. per day of ten hours.

Many thousands of these heads in operation



QUIPMENT RECENTLY INSTALLED

Mass.)



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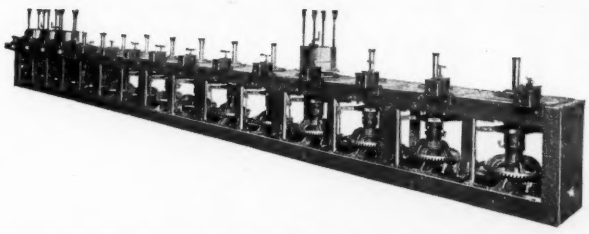
Direct driven with silent chain. Cut gears throughout. Anti-friction bearings. Variable speed for finishing block.
(New Plant of Thompson Wire Co., Worcester, Mass.)



Heavy 16" Frame For .65 Carbon Wire No. 10½ to .037"

15 Blocks: Motor driven. Silent chain. Anti-friction bearings and cut gears throughout.
(New Plant of Johnson Steel & Wire Co., Worcester, Mass.)

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TER MASS., U. S. A.

Wire Galvanizing Methods Discussed

Process of wire galvanizing and the equipment used is treated in a non-technical manner--- Directions for drossing and dross sweating given

*By Clement F. Poppleton**
Consulting Engineer, Pittsburgh, Pa.

THE most important galvanized product, commercially speaking, is sheets, which the writer has already dealt with exhaustively in other published articles. The next important galvanized product from a commercial standpoint is wire. Before proceeding to describe and illustrate the galvanizing of wire it will perhaps be well to give some data on the conditions which must be met and overcome to galvanize any product.

The first step, and most essential is to thoroughly clean the article to be galvanized. This is accomplished, usually by the process known as "pickling" which consists of immersing the article in a bath of acid. If sulphuric acid is used exclusively the solution may vary from 4 to 10 per cent by weight, of commercial acid, the usual range being about midway between the extremes. To give the best results the solution should be heated, this is usually accomplished by introducing live steam into the pickle tanks.

Pickling

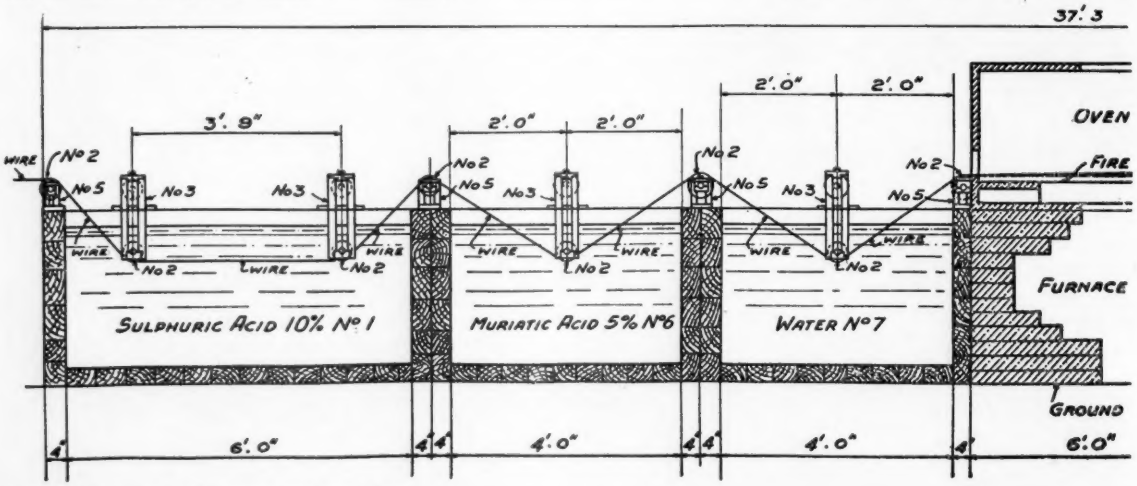
Articles may be pickled by simple immersion, but this is very uncertain and consequently the articles are usually agitated in the solution, either by hand or mechanically. Where the article is of such a nature as to permit of mechanical manipulation that method is preferred, as it is regular in action and each article may be so handled as to receive an equal amount of movement in the acid solution, thus preventing overpickling. As to the correct acid strength, a solution of 7½ per cent sulphuric acid in water maintained at a temperature of 150 deg. F. is probably the best.

After pickling, the articles must be introduced into the bath of molten spelter through a flux. The object of this flux is to give a final chemical cleaning to the article and remove any oxide that may have formed on the article after leaving the pickle tank. A good flux for general utility is composed of 4 lbs. of gray granulated sal ammoniac, 2 oz. of glycerine, and 2 oz. of tallow.

The next essential for good work is that the article shall remain in the spelter bath long enough for its temperature to become equal with that of the molten spelter. If it does not become heated sufficiently it will be unevenly coated and if too cool will not be coated at all in spots while having a very heavy coating in others. On the other hand if allowed to remain too long in the spelter bath it will greatly reduce the output. Thus it will be seen that for all articles, such as wire, sheets, etc., which are passed mechanically through the molten spelter some means must be provided to vary the speed of the feed.

Galvanizing Wire

Wire, wire cloth and poultry netting are galvanized practically automatically. In this class of work it is necessary to divide the molten metal longitudinally with a flux guard consisting of an angle bar to which is attached a sheet of about 16-gauge steel extending downward below the line of the



*Reprinted from The Blast Furnace and Steel Plant.

molten spelter for about 3 inches. Immediately in front of the flux guard is the flux box filled with a very heavy flux of sal ammoniac made up as previously described. This flux must always be kept fresh by dipping out the spent flux and spreading it on the center portion of the bath between the flux box and coke retaining bar. The poultry netting, or wire cloth is fed into the flux box between rollers, and held in the bath by two rollers spaced about 2 feet apart, suspended from a frame. The netting or cloth is passed under these rollers and then led to the exit side of the bath where a revolving drum is arranged to receive the netting after it is galvanized.

Between the central portion of the bath and the exit is arranged another flux guard and the space between this guard and the end of the bath is filled with fine coke dust to a depth of at least 4 inch. The coke dust must be constantly sprinkled with water while the material is passing through. The best way to accomplish this is by means of a perforated pipe of requisite size discharging water constantly in sufficient amount to keep the coke dust on the surface of the metal thoroughly moistened.

Galvanizing Equipment

The revolving receiving drum already mentioned is so arranged that the speed may be varied to suit different weights and gauges of material. It is demountable so that the product may be easily removed when the predetermined length of roll has been run through the bath. When wire is being galvanized, several strands are passed through simultaneously and the speed varies with the gauge of the wire. Fig. 1 shows an improved automatic device for galvanizing wire. The illustration shows a longitudinal cross section of the entire apparatus which is arranged to handle the black wire as received from the wire mill, including pickling, galvanizing and coiling.

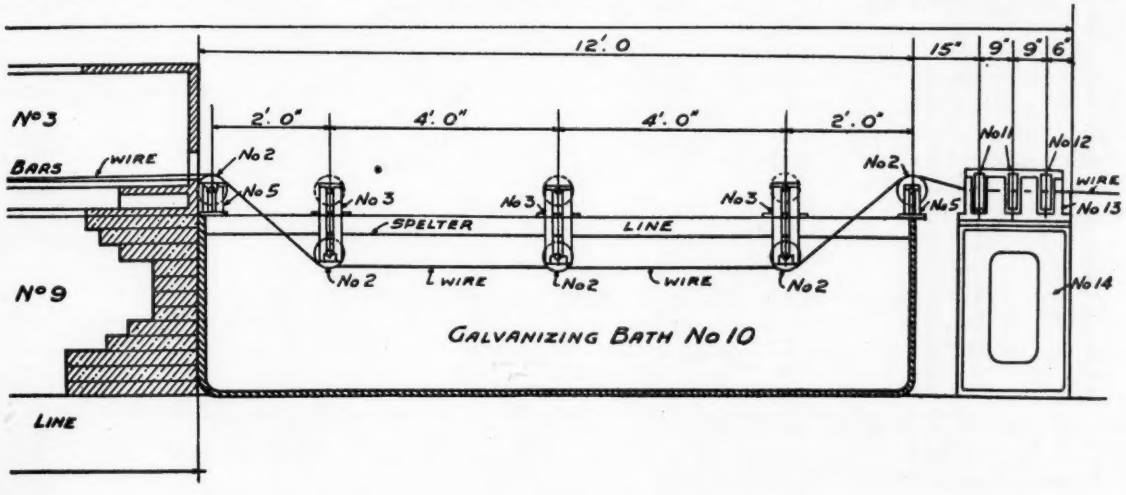
The next Installment of the series of articles on Tinsel Manufacture
By Harrison B. Williams
will appear in the May issue of WIRE & WIRE PRODUCTS

The wire to be galvanized is placed on racks at the rear of the sulphuric acid pickling vat, No. 1. It is drawn through this vat by a coiling spool placed at a suitable distance beyond the wiping brushes. No. 12. A series of porcelain or glass rollers, No. 2, mounted loosely on a shaft which in turn is mounted on brackets, No. 3, are used to carry the wires through the various vats. These brackets project above the acid bath and the shaft, bearings and rollers are slideable in the brackets. By this arrangement the strands of wire can be threaded in a horizontal straight line without having to touch the acid. The brackets supporting the shafts, bearings and rollers are then forced under the acid and wedged into the working position. As the rollers are mounted independently, one wire, in case of a breakage, can be fixed independently without stopping the balance of the apparatus. These shafts and bearings are of acid proof metal, while the rollers as already mentioned are of either glass or porcelain. Rollers are also provided on partitions between the vats to carry the wires.

After passing through the sulphuric acid pickling bath, the wires are led over another series of rollers and brackets into the muriatic acid pickling vat, No. 6, and then into the washing bath, No. 7. The washing bath must be kept fresh by a constant supply of running water. While the rollers in the water bath need not necessarily be of acid proof metal, they are usually duplicates of those used in the other vats so as to permit interchanging.

The Drying Oven

From the washing bath the wires pass into the drying oven, No. 8, which consists of a cast



iron box filled with grate bars to retain the heat. Its function is to drive off the entrained hydrogen from the outer surface of the wires. This oven is mounted on the top of furnace, No. 9, built of fire brick and fired with either coke, coal, or gas. Of the three fuels, coke is

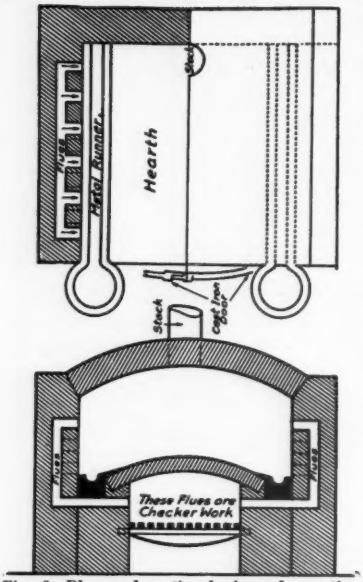


Fig. 2—Plan and sectional view of sweating furnace.

to be preferred as the galvanizing bath is usually heated with that fuel.

The next step in the process is the actual galvanizing. The spelter bath, No. 10, is arranged in line with the oven and the wires pass through the spelter under and over rollers and brackets in the same manner as they pass through the acid baths. After being galvanized, the wires pass through two sets of dies. Nos. 11 and 12, set to grip the wires on opposite quadrants and are adjustable for various gauges. The final wiping through asbestos brushes removes all surplus spelter and leaves the product with a fine finish. Passing the wire through the two sets of dies while the wire and spelter are still hot drives the coating into the steel or iron, reduces thickness of coating, and gives the coating much greater adhesion to the base, making a better product as the coating is so firmly attached to the base that it can

(*Please turn to page 133*)

NEWS OF THE INDUSTRY

BRITISH HOOKS AND PINS INQUIRY CONCLUDED

THE inquiry under the Safeguarding of Industries Act of Great Britain into an application for an import duty on hooks and eyes, pins, snap fasteners and other small wire goods, which has been proceeding for several weeks before the Board of Trade Committee in London, has now been concluded. Sir George Lowndes presided over the final sitting of the committee. B. Faraday, for the applicants, completed his case by asking the committee to hold that on the evidence and facts before them the applicants had established a case for the protection of their industry.

N. L. Macaski, for the opposition, contended that the industry represented by the applicants was not one of substantial importance either by reason of the nature of the articles produced or by reason of the number of operatives employed. The importation of the articles concerned, he said, could not possibly be regarded as abnormal. He further declared that importation could not possibly be said to be facilitated by the disparity of wage conditions abroad, and he submitted that the applicants were not entitled to claim an import duty on the conditions indicated in the application.

The inquiry then closed and the committee is now at work upon the preparation of its report.

Carroll Wire Company In Bankruptcy

A petition in bankruptcy was filed yesterday afternoon in New Haven by the Carroll Wire Company, Inc., of Waterbury Conn. The assets of the concern listed are $48,686 and the liabilities are listed at $57,125. The concern is located on Brown's Meadows, off Watertown avenue.

NEW OIL-PROOF ELECTRIC CABLE INTRODUCED

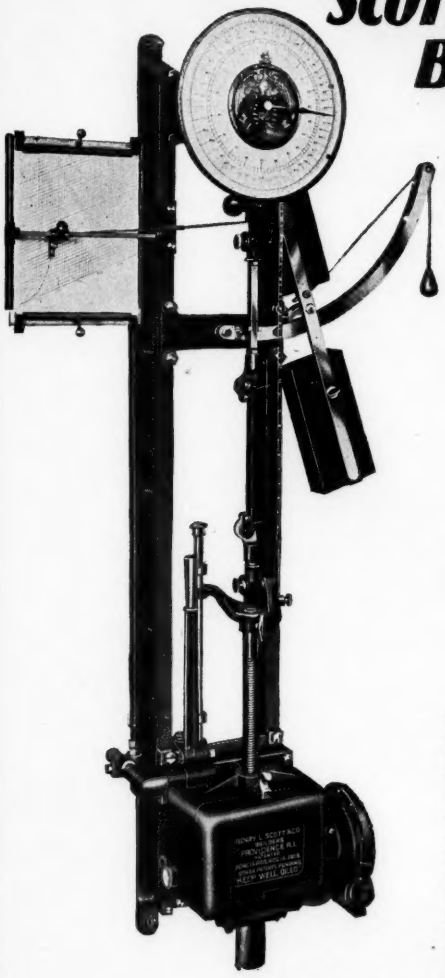
A NEW type of insulated cable has recently been introduced by the Mersey Cable Works, Ltd., Bootle, Liverpool, to meet the demand for cables which will give service in oily situations as, for example, in motorships, where rubber and similar types of insulation are apt to give trouble. The makers claim that their symoid cables (as the new type is called) are impervious to oil and oily vapor (of the highest density), even under prolonged and continuous exposure at high temperatures. Similarly, they remain unaffected by either fresh or salt water, steam, etc., while they are flame-resisting to a remarkably high degree.

Exposition Site Now Residential Section

TO have permitted the work of salvage to eradicate all trace of the Panama Pacific Exposition would have been a serious mistake, both from an economic and aesthetic standpoint. Through the untiring efforts of the Exposition Preservation League and City Engineer H. M. O'Shaughnessy, San Francisco now has on the Exposition site a residential district.

SCOTT TESTERS

SCOTT TEST FIGURES PROTECT BOTH BUYER & SELLER



The use of Automatic Record is optional—visable reading may be taken direct from dial.

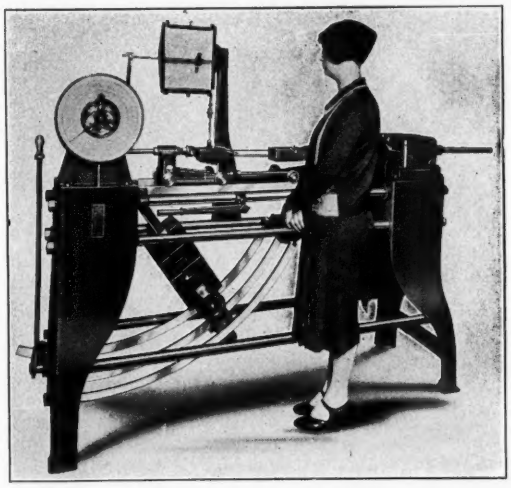
Wire diameters are NOT strength standards

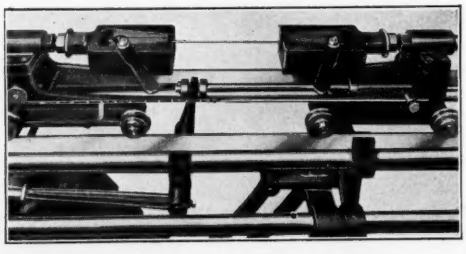
Scott Testers give accurate readings—permanent records of strength, elasticity, elongation and action under stress. These readings enable you to establish fixed standards as a basis both of purchase and use. Every Scott Tester is built for service—accurate, rugged, easy to operate and free from delicate adjustments and complications.

Illustration at the left shows Scott Wire and Metal tester—vertical type with maximum capacity of 500 pounds.

HORIZONTAL & VERTICAL TESTERS

This type of tester is applicable to a wide range of work and is considered by many to be the most convenient for general use. Belt or motor driven—high or low speed, gearing as may be required.





These machines with different types of clamp may be used on a great range of materials—such as Wire, Chain, Sheet Metals, Tire Fabrics, Ducks, Webbing, Cordage, Rubber, etc. to determine both tensile strength and elasticity.

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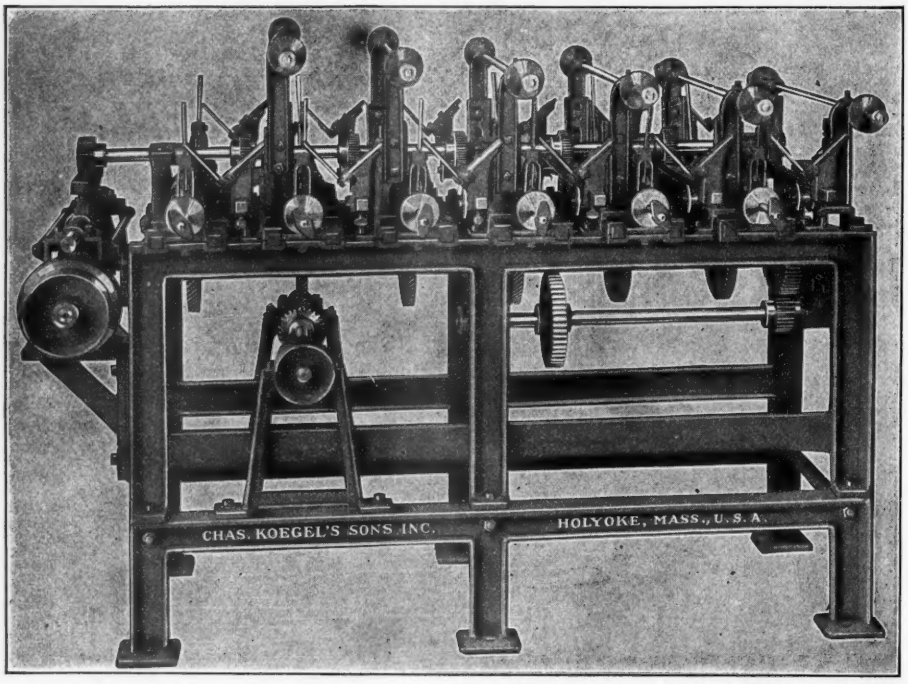

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What is perhaps the most popular feature of this great project is the preserving of the famous Yacht Harbor which will be remembered by thousands of Exposition visitors.

Recently work was started on extensive improvements at Yacht Harbor which includes an extensive system of slips and berths for the numerous yachts now being kept here. Projecting out from the shore there have been constructed concrete piers as shown in photo No. 1. and extending from the edge of the pier to the pontoon there is a heavy gang plank. The end of the gang plant is hinged to the edge of the concrete pier while at the other end there is arranged a roller resting on the top of the pontoon permitting it to adjust itself as the pontoon rises and falls with the tide. At this point on the pontoon there is erected a gate made of wire fence which is always kept locked and only those having authority to board the yacht are provided with keys. Projecting on either side of the gate is a panel made of wire fence which effectively keeps all unauthorized persons from passing through the barrier.

THE Owl Wire Works, located in Oakland, Cal. last year, has begun intensive manufacture of bird cages and floral designs in 10,000 square feet of floor space.

It is expected that the annual output value this year will approximate $15,000. All types and sizes of bird cages will be made in this plant, which will serve the entire state of California.

E. Kather is manager.

The plant contains a total area of 61,806 square feet, 20,000 of which are under cover.

PURCHASE of the Stephen Richard Company, Inc, of Southbridge, by the Parker Wire Goods Company of this city, was announced today by officials of the wire goods company. The manufacturing plant will be continued in Southbridge, but headquarters for sale and shipments will be at Worcester. The announcement

Wire Galvanizing Methods Discussed

(*Continued from page 130*)

be bent and worked without the danger of peeling. The wires are then wound on spools driven by motor or other suitable power, and so arranged that one or more spools may be removed independently. This entire apparatus occupies a floor space of about 38 ft. x 6 ft. independent of the black and galvanized wire spools.

Effect of Hydrogen in Galvanizing

A feature generally little understood, and which hitherto has not received the attention it merits, is the action of hydrogen in its relation to the spelter coating of wire or sheets of either iron or steel. The following quotation from G. A. White's book entitled, "A Metallurgical Study of the Steel Base as Related to Galvanizing," throws considerable light on the subject.

"In the pickling process moisture or hydrogen, as well as the arsenic in the acid, may also produce these results (rough and heavy coating on wire or small granular spangles on sheets). It is generally known that hydrogen can largely be removed from iron by soaking it in water. A number of sheets were soaked in water for a week and then taken out and galvanized, the result was large spangles (i. e., light coating). It is therefore apparent that the hydrgen taken up by the sheets in the pickling operation is largely responsible for the small spangles on sheets and the corresponding condition in wire. Another experiment was made, galvanized sheets were pickled to remove the spelter coating and the hydrogen gas was afterwards driven off by heating the sheets to a temperature of about 800 deg. F. When galva-

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THOROUGH cleaning is essential to successful plating. The best way to prepare wire for a perfect plate is to clean it with an Oakite material.

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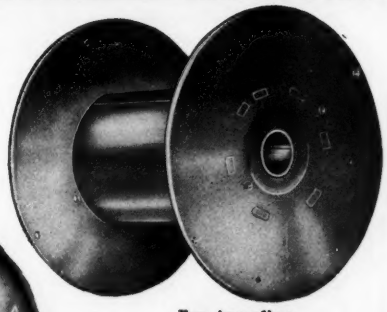

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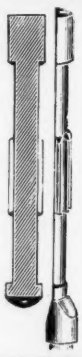

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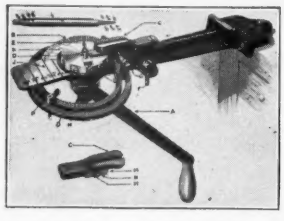


Patented April 2, 1918

M. D. Kilmer & Co. **Cleveland, Ohio, U. S. A.** Box 237, Station B.

nized after this treatment the resulting spangles were large." The foregoing is the reason for the inclusion of the drying oven in the apparatus just described. In the apparatus under description, from 18 to 30 wires may be galvanized at the same time.

Buildings Should Be Well Ventilated

All buildings in which galvanizing operations are carried on should be of ample height and well ventilated. As the fumes from the acid tanks and the spelter bath do not readily escape, some means must be provided for their removal. A good ventilator should be installed in the roof, and moveable hoods should be provided over the acid tanks and galvanizing kettle. The hoods over the acid tanks need not be movable, but one over the spelter bath must be to allow free access to the kettle for the purpose of drossing, whether moveable or fixed the hoods should be rectangular in form and sufficiently large at the bottom to extend out over the tanks and kettle. The hoods on all sides should slope toward the top at an angle of about 30 deg. and connect with a suitable pipe provided with an exhaust fan of ample size. If this is thoroughly done the working conditions will be fairly comfortable. Hoods should be arranged as low as possible over the tanks and kettle so as not to interefere with the workmen. When hoods are arranged over large tanks or kettles, they should be mounted on a trolley or an overhead track to allow of easy manipulation for drossing.

All buildings used for galvanizing purposes should be of brick, stone or concrete, and the roof trusses should be of timber, preferably yellow pine, covered with slate or tile.

Disposal of Spent Liquors

Considerable water is used in the process of galvanizing and provision must be made for proper drainage. The best plan is to provide catch basins under the various acid and water tanks and connect these by means of tile pipe to the sewer. Too much

stress can not be laid on having all conductors connected with the process of galvanizing whether for spent acid, water or fumes, of ample size. In the layout of a galvanizing plant, some method must be arranged to deal with the spent acid within the plant itself, as nearly all municipalities prohibit the discharge of acid into the municipal sewer system. If the quantity to be disposed of is large, it pays to install an acid recovery plant. At John Sommers Sons, Ltd., Chester, England, such a plant was installed and proved to be a highly remunerative investment. The oxide of iron recovered (used as a pigment in paint making) more than paid for the cost of operation and interest on the investment, and left the recovered acid as clear profit.

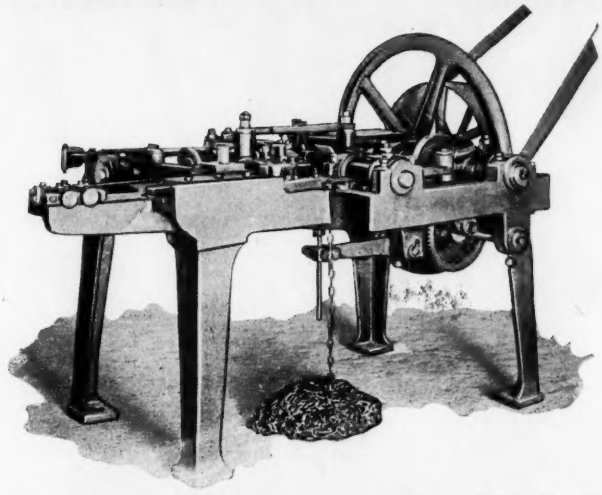
For the purpose of heating the acid and water tanks, a supply of live steam must be provided, and as this is of low pressure, exhaust steam may be used if available, but this is seldom the case in modern plants which as a rule are motor driven.

The Galvanizing Kettle

It is well known that all of the common metals are soluble in molten zinc, and with the exception of lead and pure iron are miscible in all proportions. Old galvanizers used iron exclusively, but with the introduction of Bessemer and open-hearth steel; manufacturers of galvanizing equipment usually use steel because it possesses certain very distinct advantages over wrought iron. It does however go into solution much faster than did the old wrought iron and for the last 20 years there has been a constant search for a material which will work as well as steel and at the same time resist the action of the spelter as well as the iron.

In bricking in a galvanizing kettle, grates may or may not be used, the writer, however, prefers not to use grates. A fuel space of about 11 inch at the bottom tapered to 9 inch at the top is all that is necessary for ordinary purposes. The

AUTOMATIC CHAIN MACHINE



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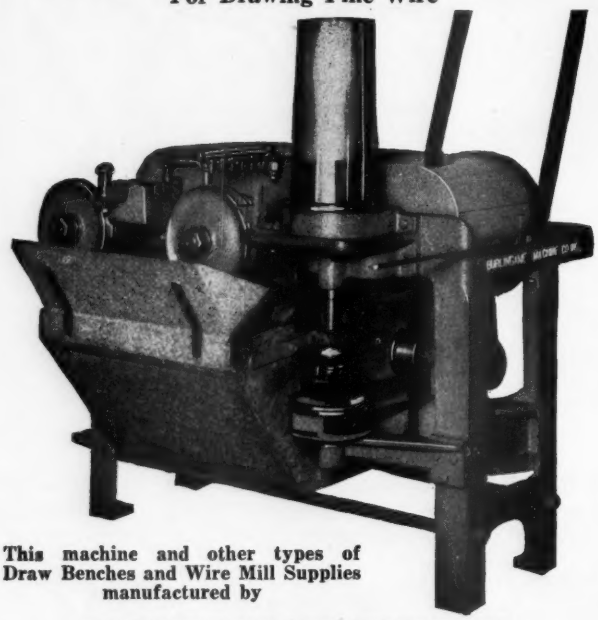

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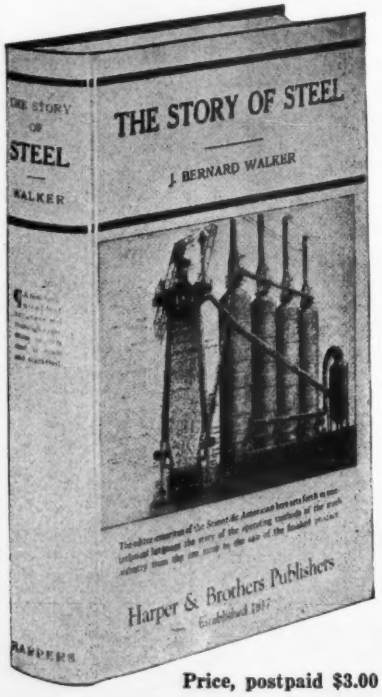

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kettles may be heated with soft coal, coke, fuel oil or natural gas, but the best fuel is gashouse coke. Cleaning holes about a brick wide (9 inch) and three bricks high, should be provided at floor level. Midway between the top and bottom of the setting, draft holes half a brick wide (4½ inch) and three bricks high are required. These are closed by means of a casting which is moveable to regulate the amount of draft. When not in use for cleaning out purposes the bottom holes may be stopped with loose bricks. The top is covered with cast iron plates about 1¼ inch thick with a lip about 4½ inch extending down over the brickwork to act as a binder. First quality highly refractory fire brick should be used for the setting.

Dross

This substance, which forms in the process of galvanizing, is composed of particles of iron or steel, in a fine state of subdivision, and more or less burnt spelter. When in operation the molten spelter is stratified. At the bottom of the kettle is a layer of lead, sometimes purposely added to afford a cushion for the superimposed layer of dross, while in other cases the galvanizer depends upon the lead content of the spelter to provide this cushion. Next to the strata of lead is a layer of dross, and above that the more or less pure zinc. This stratification results from the different specific gravities of the metals. Dross has a specific gravity between that of a spelter and steel which is nearly 50 per cent greater than that of pure zinc. The melting point of pure zinc is 787 deg. F. while that of commercial spelter used in galvanizing is about 750 deg. F. For galvanizing wire the temperature should be from 900 to 950 deg. F., as any increase above this point is injurious and results in excessive oxidation of the spelter and formation of dross.

Any temperature above 1000 deg. F., which is the critical temperature of commercial spelter, will burn the metal and form

dross, hence the galvanizers expression, "dross makes dross." A high temperature, in addition to making an excess of dross, also is the cause of excessive zinc oxide, a greater source of loss comparatively than dross, because an unequal quantity of oxide is formed. The monetary loss is greater because of the relatively low price which is obtainable for oxide, "zinc ashes," as it is known, as compared to dross.

Spelter Temperature Must Be Carefully Controlled

"Zinc ashes," after refining, is used as a pigment in paint making, but as it is very impure and stained with sal ammoniac it can not be used for white zinc paint. This operation or drossing is very important and is performed as follows: The sal ammoniac flux is first skimmed from the top of the kettle with a dipper of thin perforated sheet iron of a suitable shape. For the sake of economy it is advisable to run the hot spent flux into shallow sheet iron pans to be broken up when cold and returned to the top of the kettle after drossing is completed. The small globules of spelter which are entrained in the spent flux are thus, also, returned to the galvanizing bath. After the spent flux has been removed, the actual operation of removing the dross is performed.

The drossing shovel or scoop is made of about ½-inch steel plate shaped like a shovel with relatively high back and sides, tapered off toward the entering edge, the bottom, sides and back being perforated with ½-inch holes fairly close together. When using this implement it is forced gently and slowly through the upper layer of spelter through the dross until the layer of lead is reached, then using the handle as a lever the shovel is slowly raised to the surface of the metal. This operation can be greatly facilitated with a single pulley block suspended from the overhead track used to remove the hood previously described. When the shovel and its contents have

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been drawn slowly clear of the metal, a slice bar should be forced through the dross and the handle of the shovel struck several smart blows with a hammer to allow the spelter entrained with the dross to run back into the kettle.

The dross is placed in molds, about 15 in. x 9 in. x 4½ in., ready for market. The dross shovel is manipulated to the molds which are placed on the floor, by means of a block. The molds are filled with dross and smoothed off with an ordinary shovel while the metal is still hot. Dross sets very rapidly so that after a few minutes the molds may be emptied and refilled.

Frequent Drossing Necessary

Drossing must be performed as often as necessary. When an excess of dross accumulates in the kettle it will show on the work. Once a week is sufficient in most cases when the kettle is being constantly operated, providing it has not been allowed to become overheated. Overheating may occur when the kettle is not in operation, and dross thus formed must be carefully guarded against. Before starting work after a shut down, the bath should be sounded to test the height of the dross. This is easily determined by the resistance encountered when an iron rod about ½ inch diameter is run into the bath. When replacing the spelter after drossing, it is necessary to see that the make-up metal is not fed too fast, as it may freeze the bath and set up very undesirable strains in the structure of the kettle.

Sweating Dross

The advisability of sweating dross is largely a matter of locality and price. Formerly, every galvanizer "ran over" his dross for at that time the very best grade of dross would bring only 25 to 35 per cent of the price of virgin spelter, while today the most inferior grades bring 50 to 60 per cent and some of the better grades as high as 80 per cent of the price of virgin metal. As it is possible that a galvanizing plant may be so lo-

cated that a ready market is not available for the wastes, it may be well to give directions for sweating dross.

A plan view and cross section through the center of the hearth of a sweating furnace is shown in Fig. 2. This furnace consists essentially of two arches of different radii, with the fire box and ash pit arranged in the center, the latter being sunk into the ground. The fuel may be natural gas, soft coal, fuel oil or gas-house coke, of these gas-house coke is to be preferred. The arch of the hearth proper, upon which the slabs of dross are placed, has a comparative short radius and terminates in two cast iron channel runways. The channels have a slope of 1 inch in 12 inches and pass through the doors to the front of the furnace where they terminate in a bowl, from which the reclaimed spelter is ladled into molds.

Care must be exercised in placing the slabs so that the products of combustion have free and easy circulation around them. As will be seen from the sectional view, the fire impinges directly upon the under side of the hearth, the waste gases passing through flues in the side walls to the top of the hearth, and then escape to the stack through suitable openings, low on the back wall.

Close fitting cast iron doors, with a renewable baffle plate on the inside and a good lap at the halves cover the entire opening in front of the hearth. The fire door is much smaller and need not be so carefully fitted, while the ash pit is usually left open. A self-supporting sheet iron stack about 18 inch diameter and 30 foot high will generally be found sufficient. The stack should be provided with a bonnet damper, operated from the ground, to closely regulate the temperature on the hearth.

When the furnace is first put into operation, the spelter will have a tendency to set in the bowls, but this condition will disappear when the heat from the runways, and hot spelter has had time to pass into the bowls. It is well to cover the spelter in the bowls with sal ammoniac flux to prevent oxidation. The spelter should be poured into molds of slightly different size from the standard spelter slabs, to differentiate between remelted and virgin spelter. Good work can not be produced if too large a proportion of remelted spelter is used. It must be remembered that it is necessary to maintain a slow even heat which must at no time exceed 850 to 900 deg. F. on the hearth, as a temperature higher would burn the reclaimed spelter and defeat the desired object.

It may be taken for granted that to sweat dross does not pay at the present time, but there may be changes in the situation, and if such occurs the information and directions given for sweating dross will be found of value.

British Cable Imports

(*Continued from page 118*)

drum. With regard to small cross-section cable and wire (principally used for internal wiring of buildings) wound on drums, bobbins, reels, or spools or made up in coils, it finds that a requirement that a tape should be inserted or a mark of origin should be printed on the core or stamped or embossed on the external rubber sheath would be unnecessarily onerous. It believes the case would be satisfactorily met by an indelible mark on the drum, reel, bobbin, or spool, or on a label attached to the coil. The bobbins, reels, or spools on which cotton and silk covered wires are wound should also bear an indelible mark of origin. Where goods are imported or sold or exposed for sale in coverings, cartons, or containers, these should also bear an indication of origin. To meet the case of sales of small quantities it should be provided that, in the case of sales from a coil, the label must remain attached to the coil. This should

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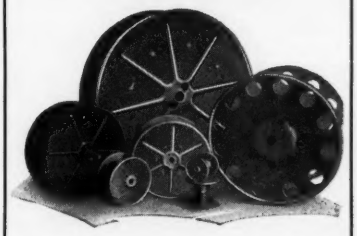

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Domestic Exports of Iron and Steel Wire, Wire Rope and Nails, From the United States, By Countries

December, 1928

Countries	Plain iron or steel wire	Galvanized wire	Barbed wire	Wire rope	Insulated iron or steel wire and cable	Wire nails
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
France	42,446	.....	.....	.....	.....	.....
Germany	60	46,270	.....	.....	87	.....
Malta, Gozo & Cyprus Is.	.....	.....	.....	342	.....	.....
Norway	7,000	.....	.....	.....	.....	127
Poland & Danzig	10,860	.....	.....	.....	.....	.....
Rumania	.....	.....	.....	11,535	.....	.....
Switzerland	13,837	.....	.....	.....	.....	.....
United Kingdom	20,766	85,746	.....	.....	.....	40,320
Canada	716,181	2,282,297	78,758	11,111	3,656	6,547
B. Honduras	.....	.....	.....	888	.....	105
Costa Rica	1,500	.....	.....	901	.....	7,336
Guatemala	38,554	6,581	76,626	3,611	.....	13,167
Honduras	1,051	.....	118,000	4,167	345	29,732
Nicaragua	4,924	.....	138,035	3,227	84	12,200
Panama	3,814	7,098	82,000	61,831	1,236	41,040
Salvador	36,050	.....	.....	70	102	800
Mexico	111,663	179,974	1,001,873	120,847	48,578	164,075
Miquelon & St. Pierre Is.	.....	.....	.....	.....	.....	3,400
Newfoundland & Labrador	168,610	1,848	.....	.....	.....	1,000
Bermudas	500	.....	.....	2,150	.....	800
Bardabos	.....	.....	.....	350	.....	.....
Jamaica	1,588	1,692	39,000	22	665	600
Trinidad & Tobago	180	540	.....	15,993	.....	.....
Other B. W. Ind.	.....	900	41,029	853	.....	5,290
Cuba	71,341	10,188	454,843	55,867	8,570	105,533
Dominican Rep.	.....	57,200	45,750	2,799	2,610	88,600
Neth. W. Ind.	.....	396	3,000	165	.....	200
F. W. Ind.	.....	.....	.....	3,140	.....	.....
Haitian Rep.	1,000	1,008	486	.....	.....	15,275
Virgin Is. of U. S.	.....	.....	6,099	.....	4,581	1,230
Argentina	501,856	2,285,898	3,376,671	49,295	529	744
Bolivia	.....	222	7,200	.....	.....	.....
Brazil	272,673	42,211	3,090,030	15,243	843	1,870
Chile	11,860	124,560	140,859	20,542	535	1,597
Colombia	89,268	67,962	380,782	59,425	29,783	244,555
Ecuador	.....	2,904	47,800	394	.....	54,934
Paraguay	840	.....	.....	.....	.....	441
Peru	20,536	17,616	49,908	49,491	.....	237,450
Uruguay	.....	.....	.....	224	.....	.....
Venezula	981	23,278	87,275	52,087	1,762	215,662
B. India	.....	139,177	.....	18,202	.....	.....
B. Malaya	.....	.....	.....	36,461	.....	.....
China	28,150	4,086	.....	.....	6,664	616,452
Java & Madura	.....	.....	194,270	14,448	.....	.....
Other Neth. E. Ind.	.....	.....	63,934	143,148	6,175	.....
Hongkong	530	.....	.....	.....	.....	.....
Japan	12,532	46,772	.....	20,266	3,267	113,502
Philippine Is.	13,000	40,642	639,925	308,035	.....	1,272,069
Siam	.....	7,130	.....	.....	.....	.....
Australia	321,119	11,164	71,630	.....	568	943
B. Oceania	.....	.....	4,480	.....	.....	3,884
F. Oceania	.....	96	4,113	.....	25	500
N. Zealand	400	.....	.....	110	.....	135
Belgian Congo	.....	.....	.....	2,890	.....	.....
B. E. Africa	.....	162	.....	.....	.....	.....
Union of S. Africa	.....	389,300	763,550	.....	.....	.....
Other B. W. Africa	.....	68,500	83,400	.....	.....	.....
Italian Africa	.....	.....	.....	.....	.....	4,409
Liberia	.....	.....	.....	.....	31	.....
Other Portugese Africa	.....	.....	.....	.....	.....	1,300
Total Quant.	**2,525,670**	**5,953,418**	**11,091,376**	**1,087,130**	**120,696**	**3,307,824**
Total Values	**119,137**	**155,420**	**302,491**	**136,379**	**25,069**	**93,060**

Shipments from the United States to Non-Contiguous Territories.

	6083 Wire		6092 Wire Nails	
	Pounds	Dollars	Pounds	Dollars
Alaska	.....	.....	.....	16,824
Porto Rico	51,640	31,961	175,765	9,775	474	309,350
Hawaii	14,353	28,443	14,221	8,432	165	122,700

give reasonable protection to the small purchaser without requiring the portion sold to bear an indication of origin.

It is recommended that an Order in Council should be made on the lines suggested in the report, in order to enforce the Committee's findings. This will, of course, be done.

Cable Displays at British Fair

(*Continued from page 121*)

caves. Connection is made to each consumer's circuit by means of "Maconite" insulated cables led in through the walls by a porcelain tube.

At the stand of the steel

Domestic Exports of Iron and Steel Wire Manufactures, Horseshoe Nails and Horseshoes From the United States, By Countries

December 1927

Countries	Woven wire fencing	Wire cloth & screening		Wire n. e. s. & manufactures of	Horseshoe nails	Horseshoes
	Pounds	Pounds	Dollars	Pounds	Pounds	Pounds
Azores & Maderia Is.	.....	.....	.....	72	.....	.....
Belgium	.....	.....	.....	913	.....	.....
Czechoslovakia	.....	.....	.....	322	.....	.....
Denmark	.....	252	75	1,530	.....	900
Finland	.....	.....	.....	100	.....	.....
France	.....	.....	.....	462	.....	.....
Germany	.....	.....	.....	33,384	91,749	.....
Greece	.....	482	112	.....	.....	.....
Italy	.....	.....	.....	6,588	8,800	.....
Netherlands	.....	.....	.....	624	2,422	.....
Norway	.....	.....	.....	2,700	.....	.....
Portugal	.....	116	48	.....	.....	.....
S. Russia in E.	.....	.....	.....	97	.....	.....
Spain	.....	.....	.....	740	.....	.....
Sweden	.....	.....	.....	364	.....	.....
Switzerland	.....	.....	.....	174	880	.....
United King.	175,182	2,764	595	107,531	.....	.....
Canada	86,521	97,086	13,010	536,974	395	214
B. Honduras	2,240	700	114	170	.....	214
Costa Rica	.....	812	181	9,379	699	13,208
Guatemala	256	2,414	515	1,563	300	.....
Honduras	9,168	1,446	169	1,633	400	11
Nicaragua	1,191	13,316	648	1,198	2,000	2,100
Panama	360	8,209	625	3,220	100	3,640
Salvador	4,874	1,390	208	756	.....	.....
Mexico	74,470	32,815	4,499	89,962	13,820	8,460
Newfoundland & Labrador	.....	324	37	462	.....	.....
Bermudas	.....	465	166	503	.....	1,000
Jamaica	1,611	1,876	247	237	.....	.....
Trinidad & Tobago	.....	172	33	906	.....	2,000
Other B. W. Ind.	4,686	1,022	148	120	.....	200
Cuba	53,427	20,647	2,322	148,610	16,700	42,800
Dominican Rep.	2,552	1,874	238	3,658	.....	1,606
Neth. W. Ind.	10,786	.....	.....	440	.....	.....
F. W. Indies	1,000	.....	.....	.....	.....	.....
Haitian Rep.	.....	410	55	.....	.....	.....
Virgin Is. of U. S.	1,125	.....	.....	331	30	.....
Argentina	79,325	11,292	1,939	7,345	44,982	.....
Bolivia	.....	1,429	246	.....	.....	.....
Brazil	3,745	4,743	1,052	68,733	2,500	.....
Chile	.....	24,155	2,048	2,969	1,900	.....
Colombia	37,231	14,867	2,040	24,817	26,300	.....
Ecuador	75	36,000	963	.....	.....	.....
B. Guiana	.....	392	70	.....	.....	.....
Peru	16,483	1,648	277	2,929	.....	.....
Uruguay	561	1,832	334	1,415	.....	1,310
Venezuela	4,753	3,235	422	5,273	1,000	.....
B. India	128,961	1,286	353	2,371	.....	.....
B. Malaya	6,209	178	113	1,189	.....	.....
China	.....	4,113	1,007	124,239	9,170	.....
Java & Madura	6,960	.....	.....	.....	.....	.....
F. Indo-China	.....	.....	.....	3,302	.....	.....
Hongkong	.....	.....	.....	120	.....	149
Japan	1,789	74,991	14,116	176,302	19,950	.....
Persia	.....	.....	.....	102	.....	.....
Phillipine Is.	74,306	7,622	1,247	15,268	14,968	38,520
Siam	570	.....	.....	.....	.....	.....
Australia	10,259	12,276	2,271	148,869	9,115	3,024
B. Oceania	.....	50	8	140	.....	.....
F. Oceania	600	.....	.....	18	.....	100
N. Zealand	166	513	112	3,464	2,360	2,856
B. E. Africa	3,759	.....	.....	.....	.....	.....
Union of S. Africa	.....	5,673	2,354	753	175	.....
Other B. S. Africa	662	.....	.....	.....	.....	.....
Egypt	.....	.....	.....	40	.....	.....
Liberia	2,004	.....	.....	.....	.....	.....
Mozambique	2,632	13,336	2,524	75	.....	.....
Canary Is.	.....	.....	.....	58	.....	.....
Total Quant.	811,499	408,223	.....	1,545,514	270,715	122,698
Total Values	37,343	.....	57,541	163,725	28,310	7,717
Shipments from U. S. to						
Porto Rico	15,743	3,208	605	43,306	1,600	32,892
Hawii	48,366	20,911	3,426	50,081	.....	1,653

manufacturing firm of Guest, Keen & Nettlefolds, Birmingham, chief interest centred on a motion picture entitled "From Ore to Fnished Product." It illustrated the blasting of the iron ore, the mining of the coal from which the necessary coke is produced, the quarrying of the limestone, the blast furnace processes for making the pig iron, and so on through the billet and rod rolling and wire drawing operations to the final stages of the manufacture of nails, etc.

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CLEVELAND, OHIO

BUYERS' GUIDE

BAKERS
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

CLEANING COMPOUNDS
Oakite Products, Inc., N. Y.

CRANES
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

DIES—Chilled Iron
The Waterbury Wire Die Co., Waterbury, Conn.

DIES—Diamond
Bellet & Bouvard, N. Y.
Cochaud Wire Die Co., New York.
F. Krause & Co., Inc., Jersey City, N. J.
Union Wire Die Corp., New York, N. Y.
Urdika Wire Die Co., N. Y. C.
Vianney Wire Die Works, New York.
The Waterbury Wire Die Co., Waterbury, Conn.

DIES—Repairs & Re-Cutting
Bellet & Bouvard, N. Y.
Cochaud Wire Die Corp., New York
F. Krause & Co., Inc., Jersey City, N. J.
Urdika Wire Die Co., N. Y. C.
Vianney Wire Die Wks., N. Y.

DRAWING COMPOUNDS
Oakite Products, Inc., N. Y.

FURNACES—Wire Annealing
Vaughn Machinery Co., Cuyahoga Falls, O.

GAUGES—Wire
A. Waldeck & Co., Cleveland, Ohio.

LATHES—Die Reaming
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Armoring (Cable, Wire, Hose)
J. I. Bernitz, New York.
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson.

MACHINERY—Balancing
Herman A. Holz, New York.
Riehle Bros.
Henry L. Scott Co., Providence, R. I.

MACHINERY—Bundling
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Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson.

MACHINERY—Cutting
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Hallden Machine Co., Thomaston, Conn.
The F. B. Shuster Co., New Haven, Conn.

WIRE WEAVING LOOMS
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Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Chain Forming
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M. A. Irmischer, New York.

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M. A. Irmischer, New York.

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M. D. Kilmer & Co., Cleveland, Ohio.

MACHINERY—Gem Clip
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M. A. Irmischer

MACHINERY—Insulating
American Insulating Machinery Co., Philadelphia, Pa.

MACHINERY—Nail
J. I. Bernitz, New York.
M. A. Irmischer, New York.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Pointing
M. A. Irmischer, New York.
Morgan Construction Co., Worcester, Mass.
Standard Machine Works, Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Pin & Needle
J. I. Bernitz, New York.
M. A. Irmischer, New York.

MACHINERY—Screw Wire
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Spring Making
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MACHINERY—Staple
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M. A. Irmischer, New York.
F. B. Shuster Co., New Haven, Conn.

MACHINERY—Stranding
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M. A. Irmischer, New York.
New England Wire Machinery Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson.

MACHINERY—Spooling
American Insulating Machinery Co., Philadelphia, Pa.
M. A. Irmischer, New York.
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MACHINERY—Panning
American Insulating Machinery Co., Philadelphia, Pa.

MACHINERY—Testing
Herman A. Holz, New York.
Riehle Bros., Phila., Pa.
Henry L. Scott Co.

MACHINERY—Winding
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Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Wire Drawing
American Insulating Machinery Co., Philadelphia, Pa.
Broden Const. Co., Cleveland, Ohio.
Burlingame Machine Co.
Kratos Wks., N. Y. C.
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Superior Tool & Mfg. Co., Worcester, Mass.
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Oakite Products, Inc., N. Y.

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Apco-Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

PRESSES—Rivet & Bolt
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R. H. Miller Co., Homer, N. Y.

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Apco-Mossberg Co., Attleboro, Mass.
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Mossberg Pressed Steel Corp., Attleboro, Mass.

TRUCKS
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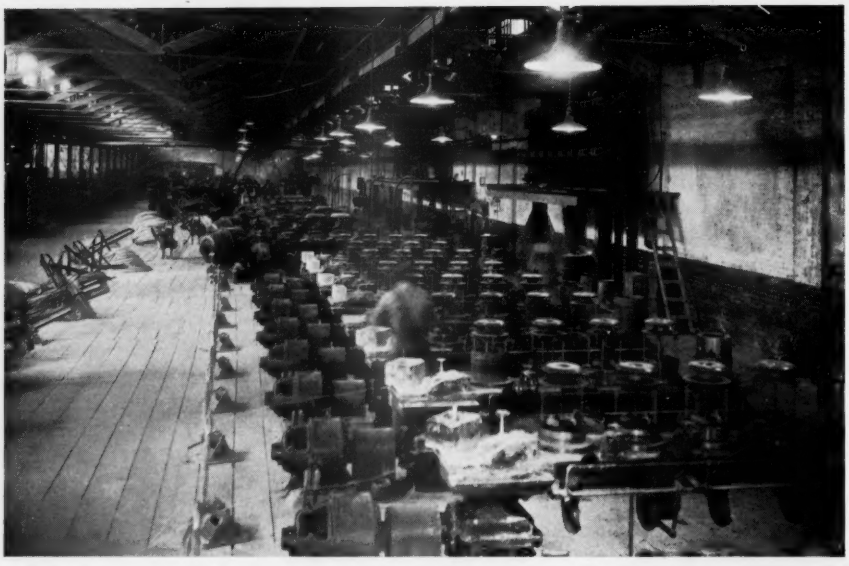

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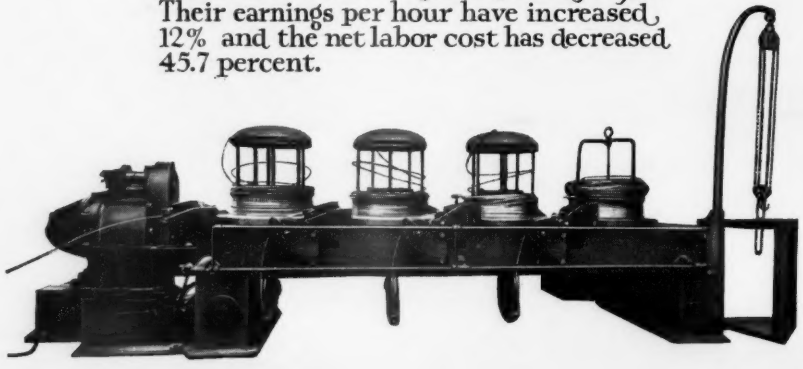

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